COAL AGE

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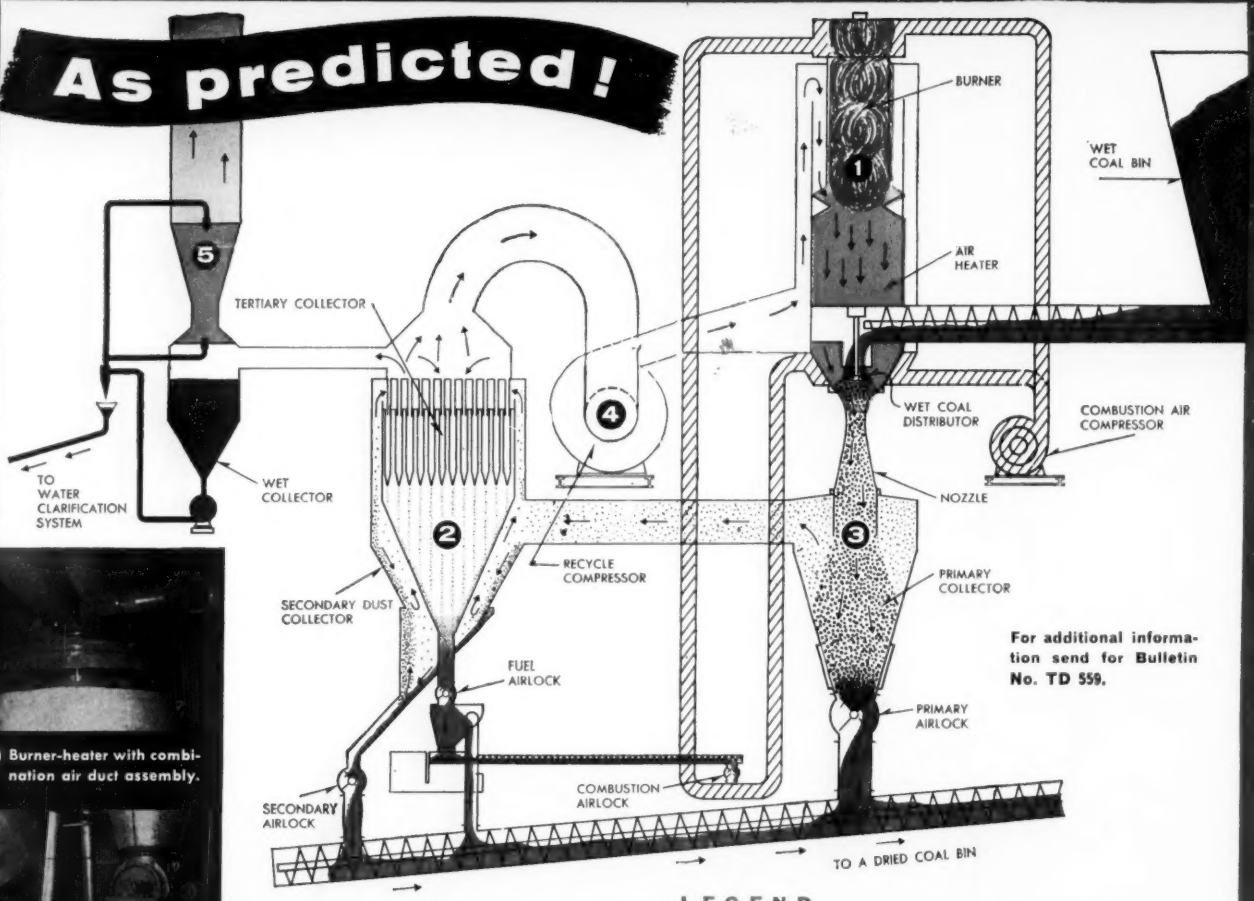
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JULY, 1960 A McGRAW-HILL PUBLICATION PRICE $1

As predicted!



For additional information send for Bulletin No. TD 559.

LEGEND

Large Size Coal (majority of product)	Fine Dust	Extreme Fine Dust	Outside Air (atmosphere)	Flame in Burner	Heated Gas	Recycled Gas	Completely Scrubbed Gas Exhausted to Atmosphere	Partially Scrubbed or Cleansed Gas	Coal	Water Containing Extreme Fine Dust

Burner-heater with combination air duct assembly.

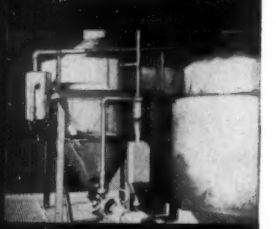


Lower section of secondary dust collector at left;

Primary collector with airlock at upper right; and clean coal collecting conveyor.



Recycle compressor and upper section of secondary dust collector.



Wet collector and exhaust duct for scrubbed gas.

LESS HP = $$ SAVED
MORE BTU = BETTER PRODUCT

FAIRMONT-built TAILOR STREAM-FLO THERMAL DRYER*

The new Tailor Stream-Flo Thermal Dryer dries feed products up to 2"; recovers the finest dusts. Product is conveyed through drying chamber by gravity, thereby using much less horsepower.

The Tailor Dryer produces a dried product with 200-300 BTU per pound higher heating value compared to other dryers because of the lack of oxidation within the drying atmosphere.

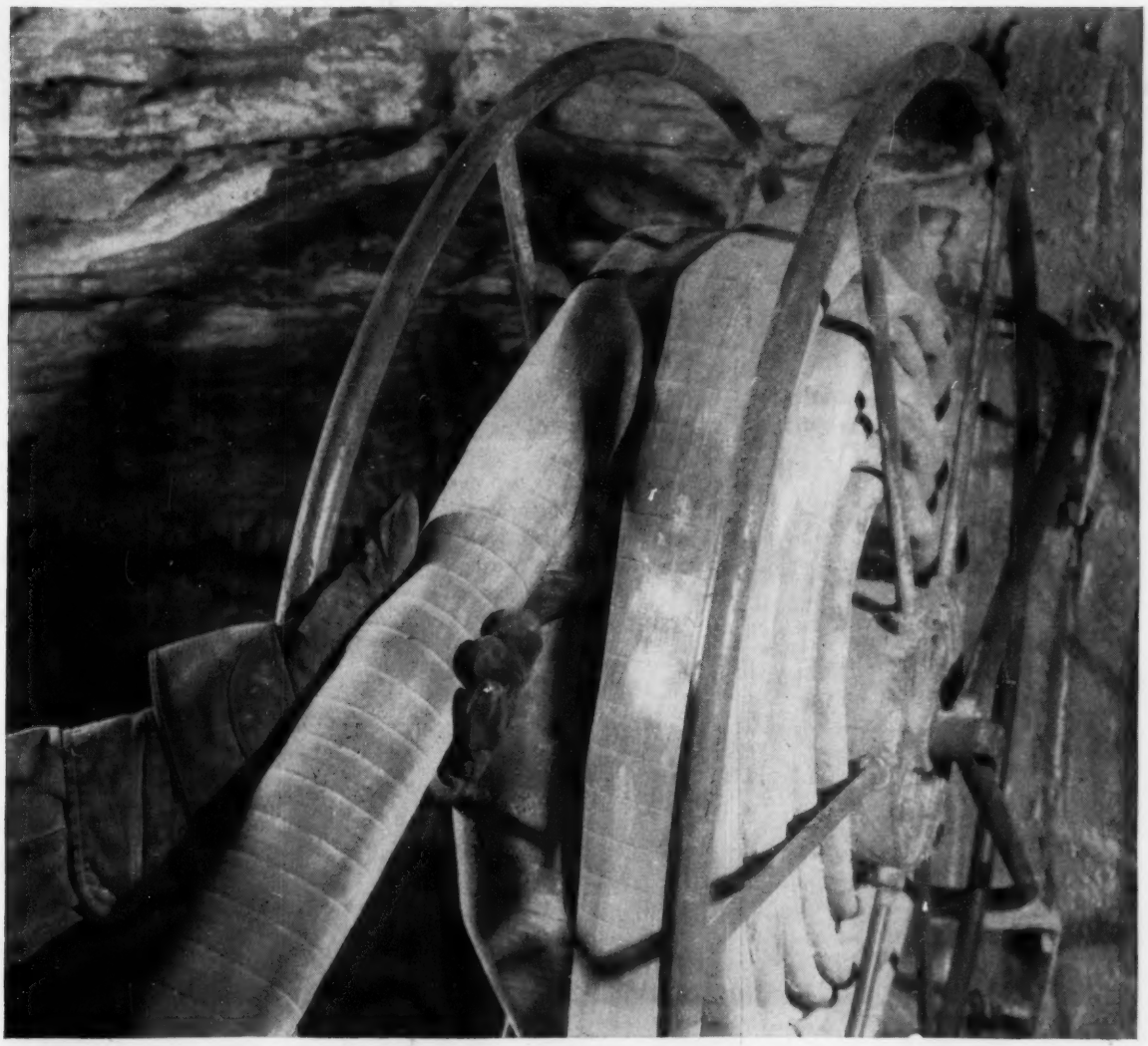
The compact, low maintenance assembly comprises only five major elements in its entire system!

*Tailor Stream-Flo Thermal Dryer is the trade name for thermal dryers of Tailor & Co., Davenport, Iowa.

FAIRMONT MACHINERY COMPANY

FAIRMONT, WEST VIRGINIA

ENGINEERS • DESIGNERS • FABRICATORS and CONSTRUCTORS



Mine operator claims this fire hose has three lives

Service life jumps from 6 to 18 months with B.F.Goodrich hose

IN this underground mine, fire hose had to be replaced every six months. Acid, water and mine dampness caused cotton-jacketed hose to mildew and rot. Hose life was further shortened by constant exposure to abrasive dolomite dust.

Then a B.F.Goodrich distributor told the mine superintendent about a new industrial fire hose, developed by B.F. Goodrich to overcome just such problems. A special rubber compound was developed for the cover of B.F.Goodrich Pinnacle hose to give it high resistance to acids, chemicals, weather, abrasion and just about everything else that ruins regular hose.

After 1½ years in this underground mine, this improved B.F.Goodrich hose showed no sign of mildew or rot. The operators expected it to last far longer than any hose used previously.

The use of Dacron, a chemically produced fiber, as "filler cords" in the woven jacket makes this hose extra light, more flexible, easier to handle. It weighs only half as much as regular rubber-covered hose, takes far less storage space whether coiled or folded.

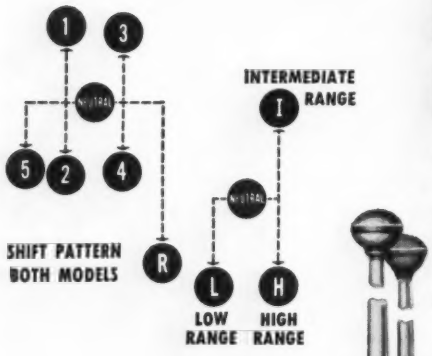
Your B.F.Goodrich distributor has exact specifications for this hose. And, as a factory-trained specialist in rubber products, he can answer your questions about the many rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Co., Dept. M-866 Akron 18, Ohio.*

B.F.Goodrich

FIRE HOSE

NEW Fuller Heavy-Duty

10 closely-spaced gear splits plus deep reduction ratios



MODEL 15-G-1120

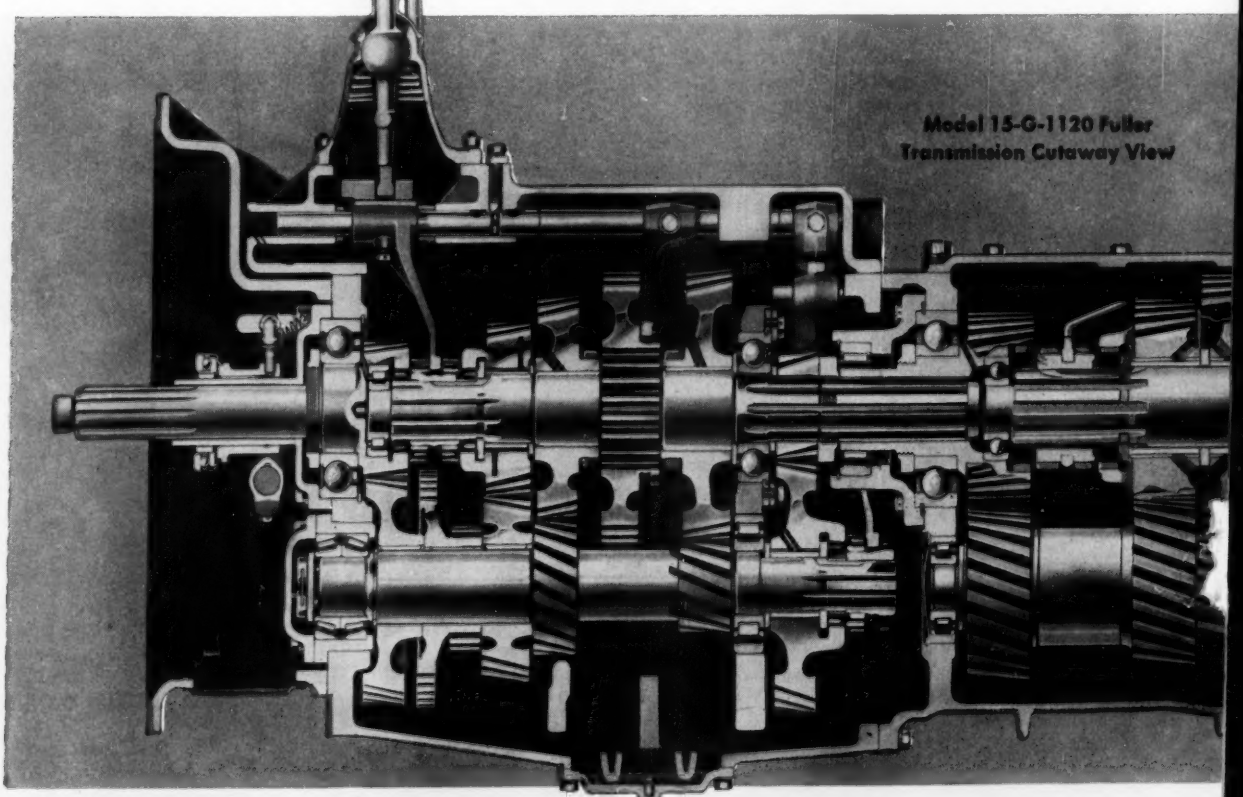
MODEL 15-K-1120

Fuller now offers two new 15-speed transmissions engineered for on and off-highway diesel truck operations demanding high capacity, long wear life and ease of operation . . . for logging, mining, construction, oil-field work, aggregates and ready-mix.

Advantages of the new transmissions include:

1. Extremely short installation dimension, which permits shorter wheelbase for tractors which formerly incorporated main and auxiliary transmissions.

2. Maximum operational flexibility with not only 10 closely-spaced gear splits, but also 5 speeds avail-



Model 15-G-1120 Fuller Transmission Cutaway View

FULLER TRANSMISSION DIVISION
MANUFACTURING COMPANY
KALAMAZOO, MICHIGAN

15-SPEED TRANSMISSIONS

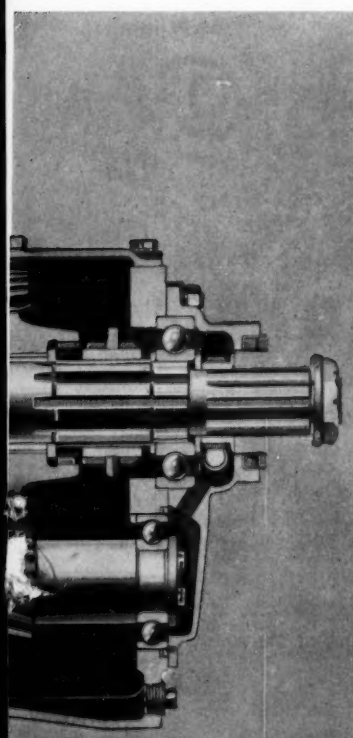
designed for combination on and off-highway applications

able for low range operation through a deep reduction in the auxiliary.

3. A wide choice of optional gear ratios to match every job requirement.

4. Weight reduction obtained by eliminating support brackets, joints, cross members and a propeller shaft.

For full details on the Fuller 15-G-1120 and 15-H-1120 Transmissions, ask your dealer or write Fuller Manufacturing Company.



Subsidiary of EATON Manufacturing Company

Model 15-G-1120: Standard Gear Ratios

SPLITS—OVER-HIGHWAY				LOW RANGE—OFF-HIGHWAY		
Speed	Split	Ratio	% Step	Speed	Ratio	% Step
10th	O'Drive-High	.636		5th-Low	1.33	
			33			
9th	O'Drive-Int.	.844				57
			19			
8th	Direct-High	1.00		4th-Low	2.09	
			33			
7th	Direct-Int.	1.327				76
			32			
6th	3rd-High	1.76		3rd-Low	3.68	
			33			
5th	3rd-Int.	2.32				86
			41			
4th	2nd-High	3.27		2nd-Low	6.83	
			33			
3rd	2nd-Int.	4.33				100
			51			
2nd	1st-High	6.54		1st-Low	13.67	
			33			
1st	1st-Int.	8.68				

Model 15-H-1120: Standard Gear Ratios

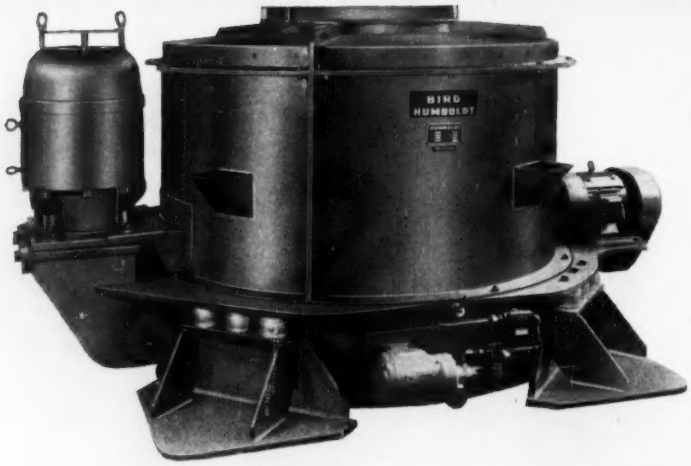
SPLITS—OVER-HIGHWAY				LOW RANGE—OFF-HIGHWAY		
Speed	Split	Ratio	% Step	Speed	Ratio	% Step
10th	O'Drive-High	.636		5th-Low	1.68	
			33			
9th	O'Drive-Int.	.844				57
			19			
8th	Direct-High	1.00		4th-Low	2.64	
			33			
7th	Direct-Int.	1.327				76
			32			
6th	3rd-High	1.76		3rd-Low	4.65	
			33			
5th	3rd-Int.	2.32				86
			41			
4th	2nd-High	3.27		2nd-Low	8.63	
			33			
3rd	2nd-Int.	4.33				100
			51			
2nd	1st-High	6.54		1st-Low	17.27	
			33			
1st	1st-Int.	8.68				

Optional Gear Ratios: Models 15-G-1120, 15-H-1120

Overdrive: .85, optional at extra cost
Overdrive: .74
Reverse: 5.06



DRY YOUR STOKER SIZE COAL *CENTRIFUGALLY*, NOT THERMALLY



For years, preparation men have wished they could dewater stoker size coal with screen centrifugals but extensive degrading made it impossible, *until the Bird-Humboldt Centrifuge came along.*

Now, excellent dewatering with essentially no degradation is being obtained in a number of plants with Bird-Humboldts. Heat drying is eliminated. *Think of the savings this can mean for you.*

Let us give you the facts and figures as they apply to your tonnage.

BIRD
MACHINE COMPANY

SOUTH WALPOLE, MASSACHUSETTS
Regional Offices:
EVANSTON, ILL. · ATLANTA, GA. · HUNTINGTON, W. VA.
LA PORTE, TEXAS · ALAMO, CALIF.

This Month in COAL AGE

JULY, 1960

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► Market Development

Research: New Catalyst for Coal Growth .. p 78

W. A. Raleigh Jr., Associate Editor, *Coal Age*

If coal is to win its rightful share of projected demands for a vastly expanding energy market, it must undertake "a great new emphasis on research." Essentially, the new emphasis means accepting research—not as a luxury or incidental function—but as a major and basic part of total operations. For coal, it means upgrading research aimed at strengthening existing and developing new markets—although not to the point of sacrificing expenditures on other components which support the total merchandising structure.

Plus Items—Proposed action program; fact-and-opinion survey of current coal research and future needs.

► Coal Preparation

Automatic Density Control ..... p 87

Underkoffler Coal Service, Lykens, Pa., uses gamma-ray radiation and associated controls to provide unattended control of the density of a magnetite-water suspension in heavy-media coal cleaning. Radiation source and detector are mounted on medium inlet pipe leading to vessel. Variations in density of magnetite, sensed by the radiation equipment, provide an electrical signal that initiates corrective action in the automatic controls. Preset separating gravity is maintained within plus or minus 0.003.

Eye-Catcher—Schematic diagram of control system.



► Stripping

Two-Engine Diesel Shovel Paces Three-Step Stripping at Hardy Coal ... p 96

Faster operating cycles, less operator fatigue and greatly reduced maintenance costs are three major

COAL AGE, July, 1960, Vol. 65, No. 7. Published monthly on the 1st, by McGraw-Hill Publishing Co., Inc. Publication office, Third & Hunting Park Ave., Philadelphia 40, Pa. United States subscription rate for individuals in the field of the publication $3 per year; single copies $1. Second class postage paid at Philadelphia, Pa. For additional information see p 9.
Postmaster: Please send Form 3579 to Coal Age, 330 W. 42nd St., New York 36, N. Y.



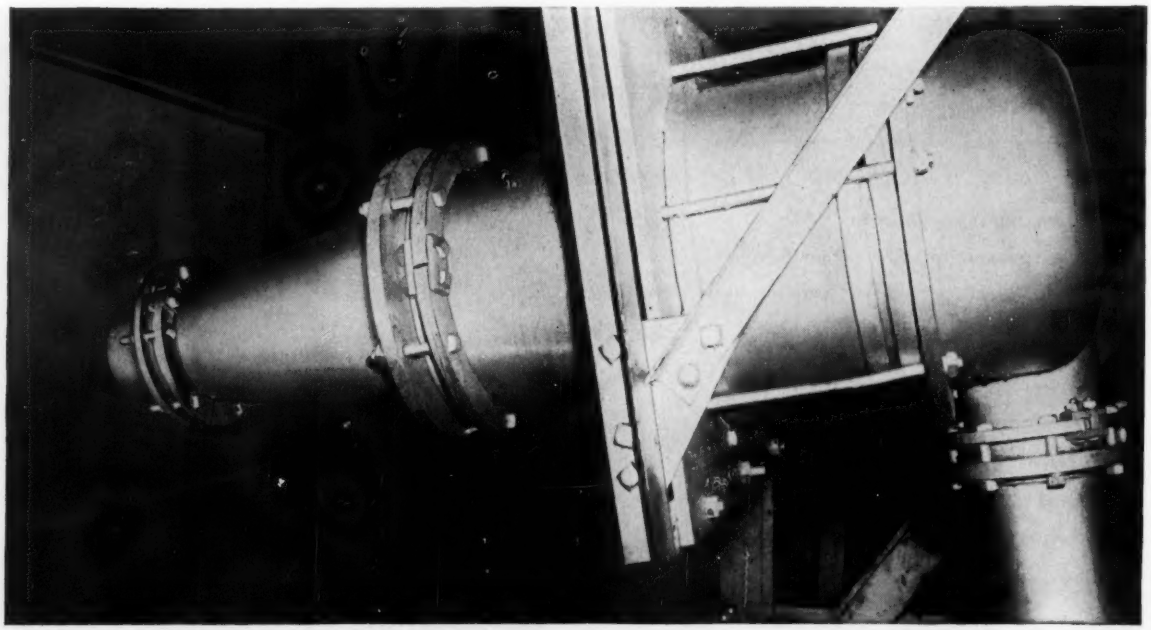
ISLAND CREEK
Precisioneered Coal

at Bartley Mine No. 1

...fine sizes are cleaned by the DUTCH STATE MINES

HEAVY MEDIUM CYCLONE WASHER

with AccuRay for continuous control of density



Heavy Medium Cyclone Washing with AccuRay control of density is used by Island Creek in its Bartley Mine No. 1 for cleaning fine sizes of its *Precisioneered Coal.*

Operating experience at Bartley Mine No. 1 and at other installations in the United States demonstrates that the Dutch State Mines Heavy Medium Cyclone Washer cleans fine coal cleaner than any other cleaning system.

It substantially increases recovery of fine coal and upgrades coal quality to premium market requirements.

If you are considering a new fine coal cleaning plant, or rehabilitation of your present facilities, get full information about the Dutch State Mines Heavy Medium Cyclone Washing System. It is available in this country exclusively from Roberts & Schaefer.

"AccuRay"® is the registered trademark of Industrial Nucleonics Corporation

ENGINEERS & CONTRACTORS

ROBERTS & SCHAEFER Company

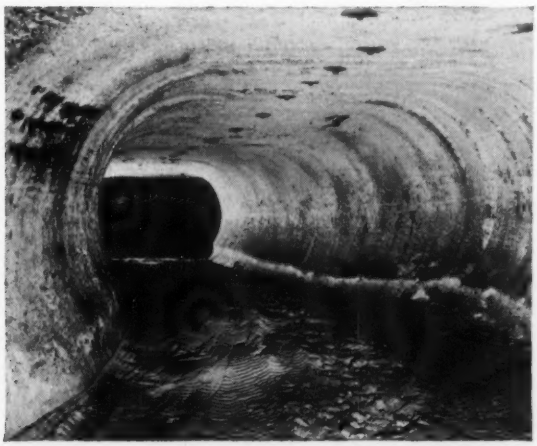
DIVISION OF THOMPSON-STARRETT COMPANY, INC.

201 NORTH WELLS STREET, CHICAGO 6, ILLINOIS

NEW YORK 19, N.Y. • PITTSBURGH 22, PA. • HUNTINGTON 10, W. VA. • ST. PAUL 1, MINN.

benefits resulting from application of a new 5-yd shovel at Hardy Coal Co., Millersburg, Ohio. Incorporating new concepts in design, the Manitowoc 4500 Vicon shovel removes 8,000 cu yd per day to expose the 30-in Ohio No. 3 coal. Stripping is a three-step operation with a D8 bulldozer teaming with the 4500 shovel to work to banks up to 60 ft high.

Highlights—Diagram of three-step stripping; how the two-engine shovel operates.



► Continuous Mining, Preparation

New Coal for Midwest Steel . . . . . *p 100*

Mining from a reserve of 100,000,000 tons, new Old Ben No. 21 mine was developed primarily to serve the metallurgical market of the Middle West. Lying under cover nearly 700 ft deep at the plant location the Illinois No. 6 seam, averaging over 8 ft in thickness, is reached by shafts, with an automatic hoist for lifting the coal in 10-ton skips.

Face equipment consists of boring-type miners, torque-converter shuttle cars and roof-bolters. Underground transportation is by ropeframe conveyor, with track and cars for supplies. Pillar recovery by driving pairs of rooms and pocketing will be practiced.

After preliminary breaking to 6 in, coal is prepared by washing in a jig (6x¼) and air cleaning (¼x0), with centrifugal drying equipment for ¼x0 from the jig circuit. Primary and secondary crushing of washed coal is provided in the flowsheet, with provisions for flexible mixing and loading on five tracks.

Highspots—Chain-hung ropeframe conveyors, special conveyor-and-bin sampling, special automatic gear for correct proportioning in mixing, plant control from one central point except for loading, remote weighing of cars with television checking.

This Month in COAL

GROUND-GAINING HALF?—If bituminous is to show any appreciable gain in tonnage in 1960 it will have to come in the second half, since the first was practically a standoff with the first 6 mo of 1959. Prospects for a gain are excellent, though nothing spectacular can be anticipated before 1961—if then. But since output hung at a little over 7 million a week in July and August of last year, and since there is every reason to expect the 8-million-plus rate of the first 6 mo of this year to continue, ground should be made up in this quarter—and perhaps a strengthening should show gain in the fourth quarter as well.

JOINT MANAGEMENT?—The continued decline in anthracite demand, in part because of a '59-'60 heating season 3.8% warmer, left the industry with a deficit of over ¾ million tons in the first half of this year. Nothing in the picture indicates any reduction in the loss rate in the second half. In other words, the squeeze gets tighter and the need for economy deepens. The effects include, among others, a proposal for joint management of the Hudson and Glen Alden properties. If it goes through, it may forecast other such moves—perhaps even in bituminous to supplement the merger trend still evident in that industry.

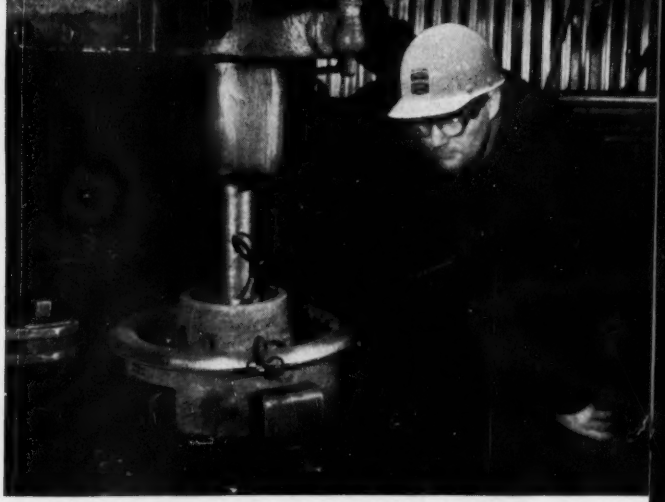
COMPETITION—DIRECT—In an abrupt reversal of form the Interior Dept. alleviated residual competition on the East Coast very materially by a significant cut in import levels. If it continues to hold to this view, coal will be afforded some very worthwhile help. Gas, however, continues to forge ahead, with both industrial and home and commercial demands helping it set new records. But with volume records it is setting new price records also.

COMPETITION—INDIRECT—Aside from direct competition, a growing question is how indirect competition is affecting coal demand in the U. S. Steel, for example, is feeling the pressure of lower-cost imports, not only in steel products but in such items as automobiles. One reason is comparative labor costs, which a French statistical organization put at $2.75 per hr for the U. S. in April, 1959, against $0.57 to $1.08 in eight of the major European countries. This differential throws the spotlight on a growing problem for U. S. manufacturers. And as far as steel is concerned, it has to contend with reduced demand growing out of the jet-like rise of the compact car.

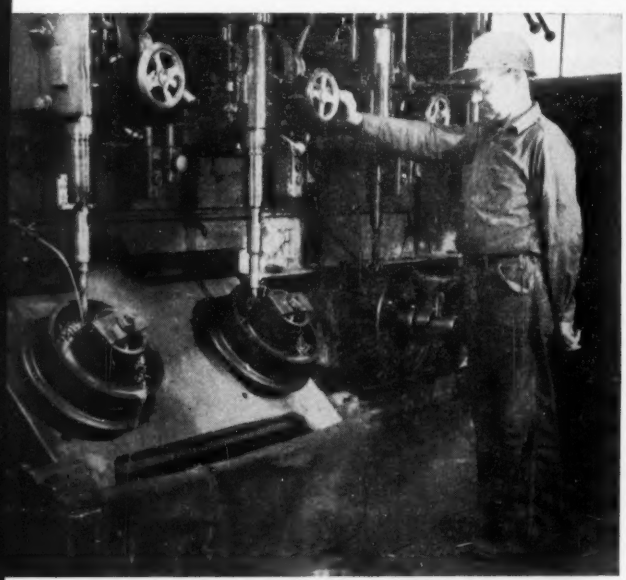
EXPORT PROSPECTS—Overseas shipments, and shipments to Canada, drifted lower month by month in the first half of 1960 with the result that tonnage was down over 20% at the end of June. Biggest losses were to Germany, Italy and Canada. The total would have been even greater had not Japan increased her takings considerably. Whether she will keep it up is a question still to be answered. Major reasons for the declines remain economic conditions, the competition of home-produced coal, and rising oil and gas use. These factors will continue to be present in the second half, and therefore further losses are in the cards in the remainder of the year. The ultimate bottom may not be sighted even in 1961.



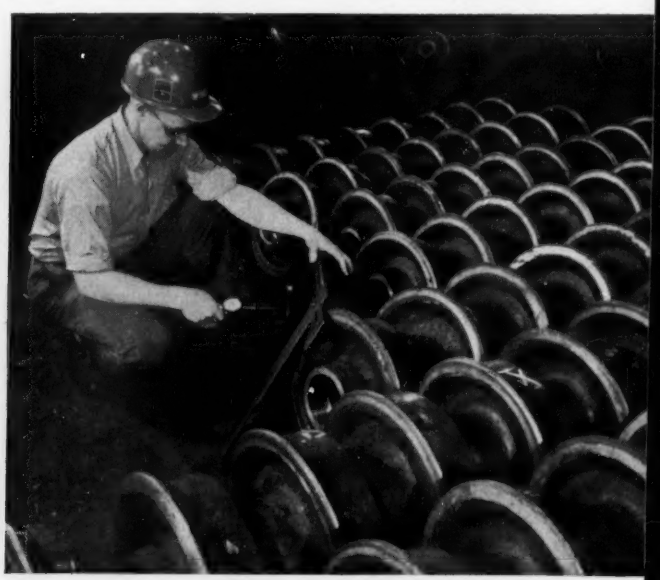
1. Steam hammer forges a heated blank to general contours of a Bethlehem Mine Car Wheel. Next, forging flash is cut off in trimming press, and hole is punched through hub.



2. This boring mill, first of several in production line, trims the flange, rough-bores the wheel, faces the back-hub. Wheel is then reversed and the front hub is faced.



3. After bearing seats are rough-, semi-, and finish-bored, this 4-spindle multiple drilling machine drills and taps for grease fitting, as well as for hub cap holes.



4. Final step in production of Bethlehem Mine Car Wheels is the inspection of finished wheel. Every Bethlehem mine car wheel receives the same rigid inspection.

Making the best mine car wheel of them all

Over the years, thousands of heavily laden trips have proved the dependability and long-range economy of Bethlehem Forged-Steel Mine Car Wheels. *Not one of these wheels has ever been reported to have suffered a broken flange, or failure of any kind.*

Made by the most modern methods, Bethlehem wheels have great strength, toughness, and resilience. They are suitable for any speeds, or operating conditions. All wheels are furnished machined, ready for installation. For further particulars, write to our nearest sales office for a copy of Folder 716, "Bethlehem Forged-Steel Mine Car Wheels."

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

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Steel *for Strength*
. . . Economy
. . . Versatility

BETHLEHEM STEEL

BETHLEHEM STEEL

► Maintenance Ideas

How to Improve Continuous-Miner Maintenance ..... *p 110*

Joseph Mason, Maintenance Superintendent, Mountaineer Coal Co., Fairmont, W. Va.

A continuous miner is a very complex machine with which to confront a mine mechanic. His training will be better served if he is taught the rudiments of its major systems—hydraulics, electrical and mechanical—separately. Inspection must be made a scheduled, necessary function. Full advantage should be taken of new bit blocks which reduce bit changing time; hydraulic-system filters will aid in troubleshooting and in keeping systems operative. Comparative advantages of in-shop or on-section overhauls should be weighed in the light of local conditions.

Spotlight On—The benefits of auxiliary equipment in keeping continuous miners at work.

D. C. McGRAW Jr., Publisher IVAN A. GIVEN, Editor

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COAL AGE, VOLUME 65 JULY, 1960, NUMBER 7

COAL AGE, with which are consolidated **The Colliery Engineer and Mines and Minerals,** is published monthly on the 1st by McGraw-Hill Publishing Co., Inc. James H. McGraw (1860-1948) Founder. PUBLICATION OFFICE, Third & Hunting Park Ave., Philadelphia 40, Pa. See box below for directions regarding subscriptions and change of address.

EXECUTIVE, EDITORIAL, CIRCULATION AND ADVERTISING OFFICES: 330 West 42 St., New York 36, N. Y. OFFICERS OF THE PUBLICATIONS DIVISION: Nelson L. Bond, president; Shelton Fisher, Wallace F. Traendly, senior vice presidents; John R. Callaham, vice president and editorial director; Joseph H. Allen, vice president and director of advertising sales; A. R. Venezian, vice president and circulation coordinator. OFFICES OF THE CORPORATION: Donald C. McGraw, president; Joseph A. Gerardi, Hugh J. Kelly, Harry L. Waddell, executive vice presidents; L. Keith Goodrich, vice president and treasurer; John J. Cooke, secretary.

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COAL AGE articles are indexed by Engineering Index. **Coal Age's** own index is published annually in the December issue.

SUBSCRIPTIONS: Send subscription correspondence and change of address to Fulfillment Manager COAL AGE, 330 West 42nd St., New York 36, N. Y. Subscribers should notify Fulfillment Manager promptly of any change of address, giving old as well as new address and including postal zone number, if any (official post office request). If possible, enclose an address label from a recent issue of the magazine. Since copies are addressed one to two issues in advance, please allow one month for change to become effective.

This month in Mining Practice

PROGRESS IN THIN COAL—Up to 40 to 50 tons or more per faceman in coal 2½ to 3 ft thick is being increasingly reported with both conventional loading units and continuous miners. Though there still will be a gap in productivity in coal of this thickness, compared to the bigger seams, these reports indicate growing progress in extracting the "pencil marks" efficiently. This reflects in turn the continued development of low-type equipment—and especially flexible, high-capacity transportation. Perhaps operators of the thinner coals can look forward to the 100 tons or better now being attained in the thicker veins—where efficiency also will advance accordingly.

TRUCK TURBINES—Nickel mining now has the distinction of pioneering the gas turbine for off-highway truck and tractor service. The unit went into operation in March in a 32-ton ore truck operating over a route including 2 mi of 8% grade. The turbine design provides twice the power of a piston engine of comparable size (225 hp in this instance), or approximately 70% more per pound of weight. It can be accepted that the unit will be a success. Therefore, look for its early use in coal stripping and hauling.

CONVEYOR BELTING—Though perhaps not quite in the nature of a revolution, there is a considerable change taking place in the conveyor-belting picture—not the least of which is a movement toward pricing more nearly in relation to relative cost. The solid-carcass belt with PVC covering and impregnation has made considerable headway, in part because of PVC but in part also because of the elimination of plies. Now the solid-carcass belt is available in neoprene, giving the mining user a wider choice of types. Since the use of belt-type conveyors continues to increase, still further developments in belting design and installation can be expected—perhaps even a British cable-belt installation in the U. S.

NEW IN GALLERIES—Even in such a thing as the housing for a belt conveyor significant progress is possible. Last month in *COAL AGE*, for example, one article featured the new prefabricated tubular belt-conveyor gallery in a modern surface plant. And a West Coast concern has come up with a channel-shaped prestressed-concrete gallery which also acts as the conveyor frame. Both these new types are low in maintenance, provide the most in protection and . . . look good.

FIRE-FIGHTING—One new idea loses some ground and another moves forward in recent fire-fighting experience in coal mines. The foam plug, for example, though still a possible potent weapon in the arsenal, has not shown up as well as hoped because of difficulties in generation and movement, among others. But modified sodium carbonate, which, unlike rock dust, is not susceptible to moisture deterioration and in addition provides an active fire-quenching agent—carbon dioxide—is showing real promise from the standpoints of continuous availability, effectiveness and cost.

THE SPLICE OF LIFE

When you splice and reinsulate with Uskorona® and re-jacket with "D.R." splicing compound, you renew the life of the cable. *The entire splice will last as long as the cable.*

These entirely reliable tapes are:

- Extra-tight gripping, plus high in tensile strength.
- Resistant to acid, alkalies and moisture ...ideal for use on mining machine cables.
- Impossible to pinhole, so dangerous leaks can't occur.
- Absolutely waterproof.

Uskorona exceeds A.S.T.M. specifications and can handle a wide range of electrical and general purpose jobs in mines. A complete line of mine tapes is available.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



US RUBBER USKORONA SPLICING TAPE



ABOVE GROUND. When spliced with Uskorona and "D.R." tapes, cables become perfect again. These splices restore the mechanical and dielectric quality of the cable, resist severe abrasion and exposure to moisture.



BELOW GROUND. Being run over by cable cars in coal mine can't hurt Uskorona splices protected by "D.R." splicing compound. They take this punishment many times a day.

US RUBBER

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

The Coal Commentator

Coal's Building

Formal dedication of the new Coal Building in Washington, D. C., June 9, was in many respects more than the formal opening of a new headquarters for bituminous coal. More significantly, it was a reflection of the new stature and outlook of the industry, and, in spite of today's low production rate, of the solid prospects for progress and profits in the days to come.

Thus, though the dedication was a milestone in bituminous history, it was no more of a milestone than the announcement of completion of the industry organizational setup with the establishment of a Research Department within the association and approval of plans for a new $875,000 coal laboratory at Pittsburgh. The formal reports of the new heads of the association divisions and departments were another milestone, marking the start on a sharpened and intensified program to improve coal's position all along the line—a program that shows real promise for progress.

The coal building is an outer symbol—and an important one—but the new approach and the new determination of the industry are the things that will get the desired results.

Steam Cooling

While on the subject of the new coal building, one of its major features is its heating—and cooling—system powered by the new industry-researched and developed automatic stoker-boiler units.

Cooling with heat (the absorption) seems paradoxical. In fact, however, it is quite practical and economical for large establishments, and other recent examples of its employment include a big apartment building on lower Fifth Ave., in New York.

Whether steam cooling will become a major competitor of electricity still is a question. It could in the large establishments previously noted, though in the home and in the smaller commercial establishments electricity will continue to rule the roost. **And if it should begin to gain in big establishments, coal would still have the opportunity to get the load directly, rather than through the power plant—and conversely could run the risk of losing the load if oil or gas was employed for boiler fuel. More push on the packaged coal unit is an obvious answer for that and for general heating and comfort.**

More With Better

One of the minor mysteries of coal mining is why, sometimes, ideas that look and are good fail to catch on. One in point is better haulage and face lighting.

Even without field tests to prove its effectiveness, better lighting is logically an efficiency-promoting step simply because if you can really see what you're doing you can do it more quickly and more accurately. But coal has available to it the results of actual installations of lighting systems designated for high productivity and safety. These results have left no doubt that better lighting, even though it involves some investment, pays off in a rise in tons per man and fewer accidents.

What ought to be done? More people should go into and use modern lighting facilities and systems both at the face and elsewhere. They are real cost-cutters.

The Problem of People

An outstanding feature of the immediate future in the U. S. is the growth in number of people in the years immediately ahead and in the farther years. This growth will bring in some problems, such as, a growing tightness in the number of people of working age, reflecting the higher percentages of both the very young and the aged—all consumers but not heavy on the producing side.

And of course the surge in population will require more of everything— for example, electric power, as the Caterpillar Tractor Co. points out in advertising and other material in its new public-service program, devoted to a discussion of twelve suggested national objectives, including the development of power-producing facilities—and the coal-producing facilities to accompany this growth, which must "triple our electric power" in the next 15 yr.

"Robert," Caterpillar's protagonist, was "born" last fall and is now less than a year old. By the time he reaches 16, coal undoubtedly will be called upon for a major increase in output to meet the needs of he and his brothers and sisters.

Vacation Bound

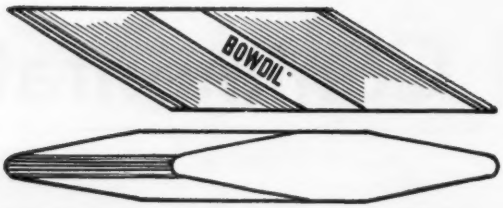
Many of us, including your Commentator, are still looking forward to 1960 vacations. **One question: Will we all get back home healthy, happy and uninjured?**

It is a matter deserving a little thought, because vacation activities can be hazardous—so much so that the National Safety Council has issued a pamphlet containing a lot of helpful hints for playing it safe while playing. You can get a copy free by writing "Vacation Bound," National Safety Council, 435 N. Michigan Ave., Chicago 11, Ill. It can do a lot to help you make your approach to vacation activities—and others—as constructive as your approach to your mining activities.

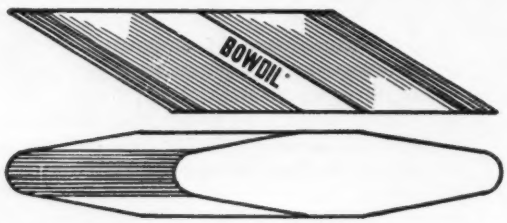
Whatever you're doing, the key idea is: "Play it safe."

There is a type of BOWDIL® Bit for every cutting need

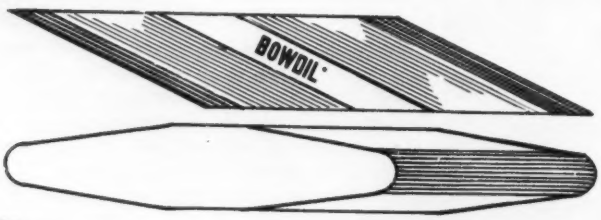
These various types are designed for specific requirements, are made from special alloy steels and are heat treated to three different tempers as listed. Through many years of research on actual conditions in the field, these styles, shapes and hardnesses of Bowdil Bits consistently prove the most popular. We are happy to offer our experience and recommendation for your individual need.



Series 1-1 — **REGULAR DIAMOND BIT, designed for use where cutting conditions are not too severe. Saves power, produces coarse cuttings. 1-1 is MEDIUM Temper, 1-1N1 TOUGH, 1-1N2 HARD.**

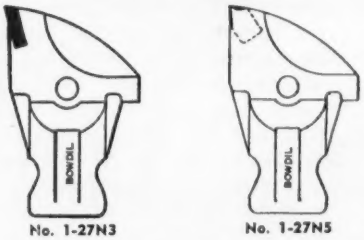


Series 1-2 — **HEAVY DIAMOND BIT is especially designed for severe cutting conditions (Iron Pyrites and Rock). 1-2 is MEDIUM Temper, 1-2N1 TOUGH, 1-2N2 HARD.**



Series 1-6 — **LONGWALL BIT is especially designed with a long cutting point for Longwall work. 1-6 is MEDIUM Temper, 1-6N1 TOUGH, 1-6N2 HARD.**

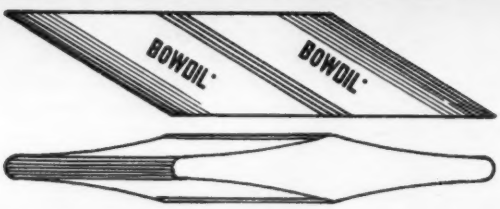
★ *Also*—CARBIDE TIP BITS



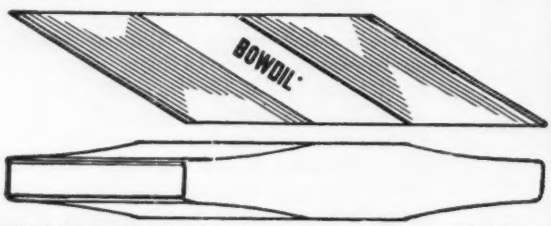
No. 1-27N3 No. 1-27N5

Superior in design and construction, with great strength and rigidity in the shank and clamping method.

TO HELP YOU RE-ORDER, PLACE YOUR TYPE BIT ON THESE ACTUAL SIZE DRAWINGS



Series 1-11 — **REGULAR CONCAVE BIT is designed for the maximum in power savings. Due to the concave shape, side clearance is automatically maintained as the face is worn away, resulting in a more uniform power consumption over the full life of the bit. No. 1-11 is MEDIUM Temper, 1-11N1 TOUGH, 1-11N2 HARD.**



Series 1-29 — **HEAVY DUTY CONCAVE BIT has the design features and similar cutting advantages of the Regular Concave, but is made heavier for very severe service. No. 1-29 is MEDIUM Temper, 1-29N1 TOUGH, 1-29N2 HARD.**

★ **ALL STYLES EXCEPT 1-6 LONGWALL ARE NOW AVAILABLE**

BOROD TIPPED



After the BOROD is placed on the Special Alloy Steel body it is heat-treated to the most serviceable temper.

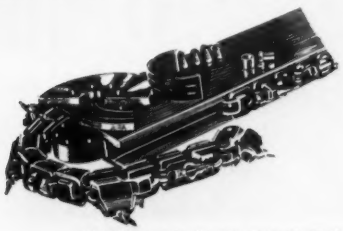
STANDARD ORDER NUMBER	BOROD ORDER NUMBER
1-1	1-19
1-2	1-20
1-6	None
1-11	1-28
1-29	1-29-N4



No. 1-19

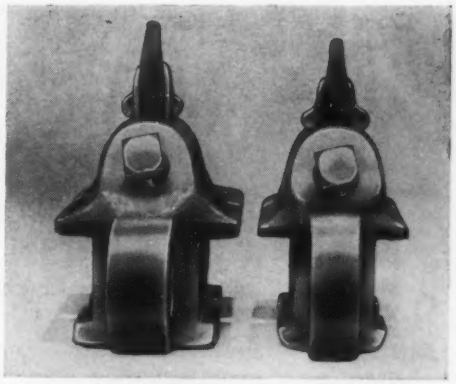
New SUPER-STRONG No. 80 CUTTERBAR

built to fit all of the newest heavy-duty machines, designed for use of the stronger new Bowdil



CHAIN #40-3

ALSO USED ON CONTINUOUS MINING MACHINES



AVAILABLE WITH BIT OPENING ½" x 1" (takes all type bits)

new #40-3 **standard #40-1**

SPROCKETS FOR ALL MINING MACHINES

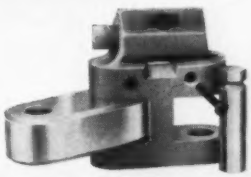
Bowdil Sprockets are made from special heat-treated alloy steel. Our stock of over 100 different styles includes clutch, spline and keyed types—various tooth designs of 4 to 13 teeth.





***New Small, Versatile* "THIN-KERF" CHAIN and CUTTERBARS**

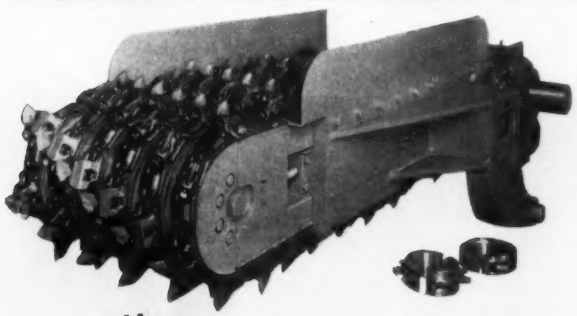
Lends itself best to use on machines delivering up to 15 h.p. and kerf of 3" to 3½". Reduces amount of cutting to the point where higher feed speeds are realized . . . and CLEANER CUTS!



Newest type TRIMMER CHAIN

for all makes of CONTINUOUS BORING MACHINES

Great strength and flexibility. Uses Bowdil Throwaway or ½" x 1" Shank Bits. Chain pitch may be varied by changing couplers only. NOTE COUPLING PIN DESIGN . . . chains may readily be assembled or disassembled with use of small hand tools.



6-IN-ROW RIPPER HEAD

Using 6 renewable independently adjusted Cutterbars, with all 6 Chains similar in kerf and lacing arrangement for interchangeability. All 6 sprockets interchangeable. Improved design head drive shaft and sprocket assembly using 2 piece sprockets to maintain extreme tension to the shaft.

These are only a few of the features and advantages in this modern Ripper Head for Continuous Mining. Ask a Bowdil representative or write for more detailed information.

Also:

"No-Bend-'em" Spike Pullers

"Changeable-Points" Hand Picks

"No-Tools-Needed" Rope Sockets



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WANT SOMETHING SPECIAL? TEL. GLendale 67176

Bowdil has the staff and facilities for economical designing and custom-building.

BOWDIL

ALWAYS *RIGHT* ON THE JOB

A breakthrough in mine safety and New "West Virginia" "W"-holegrip Unit with



Designed and fully tested by "West Virginia" engineers

A breakthrough in mine safety and time saving installation. . . . The New "West Virginia" "*W*"-*holegrip* Unit with locking keyhole plate. A completely new roofbolt assembly – redesigned from top to bottom. "W"-holegrip Unit requires less installation torque and allows preassembly, too. The new design features include:

LOCKING KEYHOLE PLATE ... allows preassembly with small center hole advantages. Bolt head pull-through is eliminated and friction reduced with tapered bolt head and flat bearing area on plate. Enlarged center hole, combined with larger bolt neck, locks bolt in place – prevents plate "walking."

NEW "W"-HOLEGRIP UNIT

- Eliminates palnut.
- No-slip slotted plug.
- Eliminates unit wobble.
- Assures proper bail tension.
- One-piece shell—fourfinger expansion.
- Plug fin prevents plug slippage.



NEW LOCKING KEYHOLE PLATE

- Features small center hole . . . reduces friction . . . eliminates bolt head pull-through.
- Keyhole punching allows preassembly with small hole.
- Locking design prevents plate walking.
- Flat bearing area with tapered bolt head reduces friction, requires less installation torque.



CONNORS STEEL DIVISION **PORTER** **H. K. PORTER COMPANY, INC.**

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

time saving installations... locking keyhole plate.

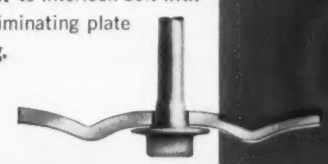
"W"-HOLEGRIP BAIL TYPE UNIT . . . features four-fingered uniform expansion shell with slotted plug to prevent "spinning" when installed. Spring bail design eliminates palnut. Snug hole in bottom of shell prevents unit wobble when pushed in place. Bolt and plug remain in perfect alignment, eliminates possible stripping of threads. Bail tension is strong enough to support unit, bolt, and plate in 1⅜" hole during drilling operations.



NEW FILLET DESIGNED BOLT . . . utilizes small head and reduces friction. Enlarged neck (fillet) *locks* bolt in center of plate.

NEW BOLT HEAD

- Smaller head reduces weight.
- Tapered to reduce friction when used with small hole plate.
- Has fillet to interlock bolt with plate, eliminating plate walking.



For complete details or demonstration, write or call:

Connors Steel Division
P. O. Box 118 RB
Phone JAckson 9-7171
Huntington, West Virginia

While Prices for Other Equipment have gone **UP** since 1954...

H&P

HEYL & PATTERSON through Progressive Engineering actually has **REDUCED** the price of Fine Coal Preparation Plants by over **5%***

(and, in fact, provides "MORE PLANT" in the bargain!)

Here is how we did it:

Conducting a diligent and continuous research program, we developed new products and processes for coal preparation. You too have successfully used some of these products:

- **H & P Fluid Bed Dryer**
- **H & P Cyclones with the new 24" and 36" sizes**
- **H & P Sieve Bend**
- **Reineveld Centrifuge**

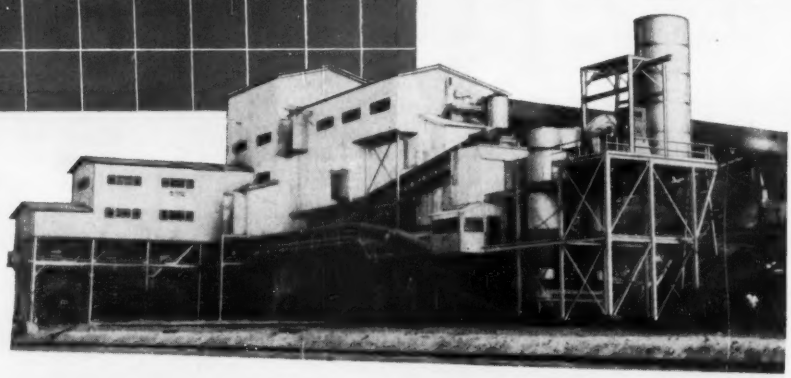
We point with pride to the real service we have rendered to the Coal Industry by being instrumental in successfully combatting inflationary trends.

In addition to lowering the initial investment, we reduced operating and maintenance costs.

In a competitive market such as coal, this means more profit opportunities for the users of H & P equipment.

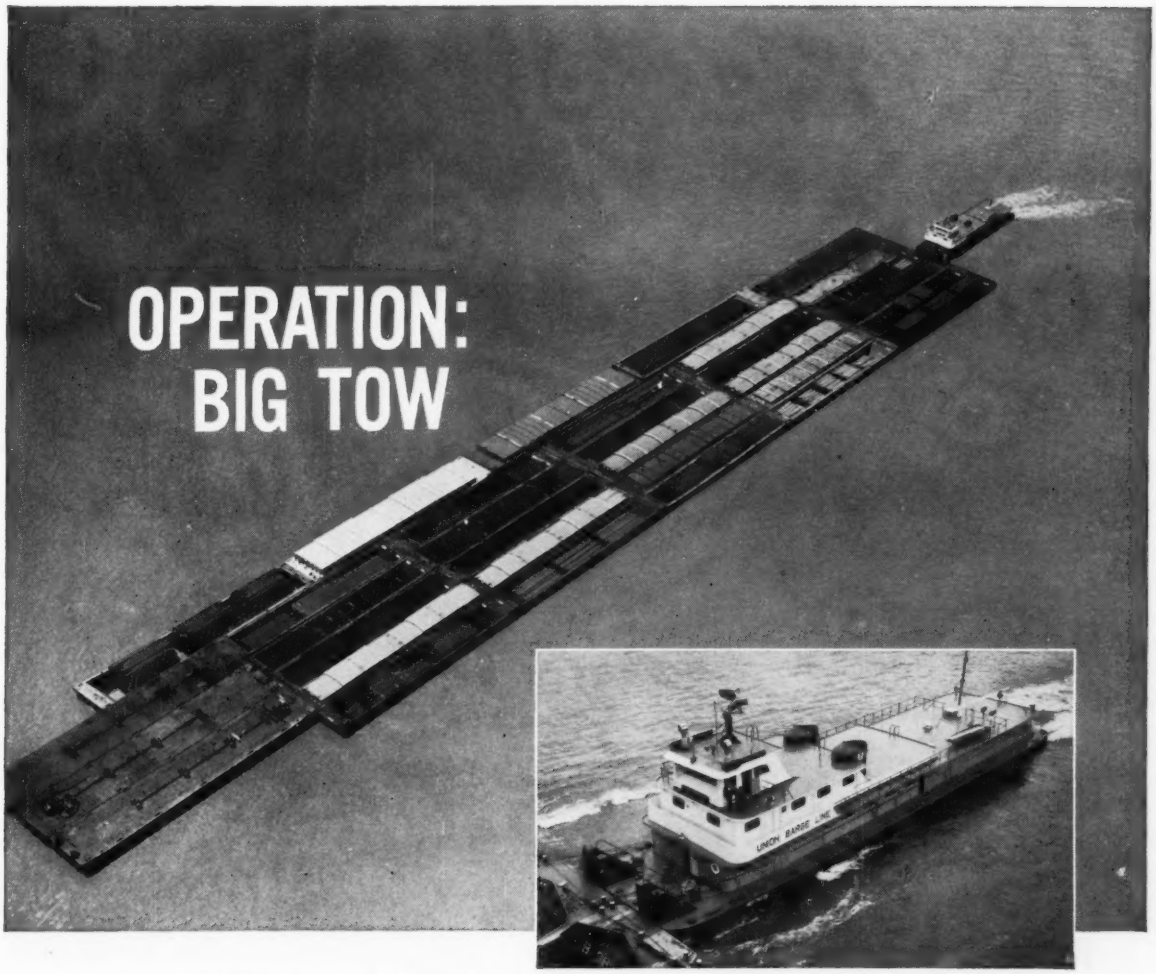
Discuss your requirements with H & P engineers whose experience is at your disposal to conceive a preparation plant best suited to your own operating and marketing conditions.

Whether you require a "turn-key" job or prefer a co-operative effort—remember: When Experience Counts—Count on Heyl & Patterson!



Comparing on a "cost per ton of plant feed basis," the actual purchase prices of similar plants, one sold in 1954, the other now under construction.

HEYL & PATTERSON, inc. 55 FORT PITT BLVD., PITTSBURGH 22, PA.



Dravo-3200 towboat "Northern" gives outstanding performance in Mississippi River service...

The tow illustrated is a good example. The *Northern* pushed this 33-barge 17,840 cargo-ton tow 231 miles from Cairo to Memphis in 28 hours and 45 minutes, including some slowdown for refueling en route.

The superior operating efficiency of the *Northern* and all Dravo-3200's is the result of Dravo's *Precision-Balanced Propulsion*. Operator after operator has reported that the PBP design gives them exceptional towing performance and unusually low ton-mile cost. It can do the same for you. For details, contact Marine Department, Dravo Corporation, Pittsburgh 25, Pa.; SPalding 1-1200.

TWO DRAVO-3200's ARE NOW BEING BUILT —AVAILABLE FOR EARLY DELIVERY

PRECISION PBP BALANCED PROPULSION

DRAVO
CORPORATION

Hulburt

Specialists in Coal Mining Lubricants

does two things for Customers

and does them well.

❶ Increases coal production by reducing down-time—lowers overall cost per ton.

❷ Offers the best lubricant, dollar-for-dollar in the coal mining industry.

. . . seemingly simple statements, but highly important to coal companies who are constantly seeking ways to reduce the cost of mining a ton of coal.



Hulburt Hydraulic Lubricants

available in:

55 GALLON DRUM

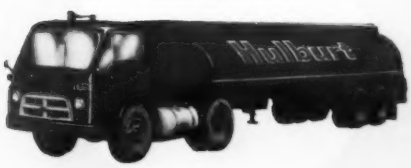
16 GAL. DRUM



5 GAL. PAIL



BULK SHIPMENT

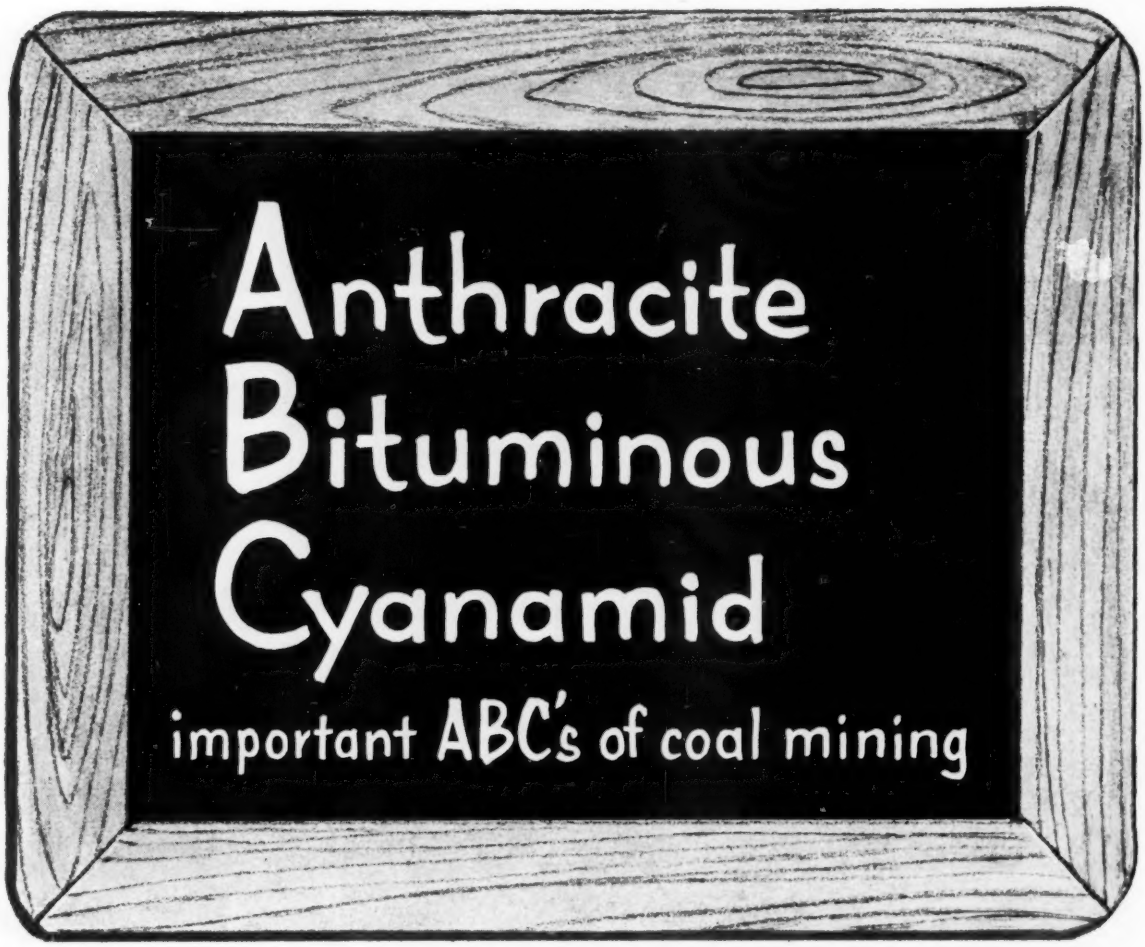


When ordering Coal Mining Lubricants

you can't be wrong in specifying Hulburt

HULBURT OIL & GREASE CO., PHILADELPHIA 34, PA.

Specialists in Quality Lubricants for the Coal Mining Industry



Whether you're shooting off the solid or shooting cut coal, Cyanamid provides the explosives and the "know-how" to improve shooting and get production off to a good start.

Cyanamid's full line of permissibles includes an explosive that's right for every condition. They are available in a variety of low, medium and fast rate powders with a wide range of densities and strengths. In addition, Cyanamid COAL KING® Electric Blasting Caps enable you to take advantage of the benefits of multiple shooting of coal.

Like other Cyanamid explosives, electric blasting caps and blasting accessories, our permissibles and COAL KING caps are manufactured under strict quality controls for assured dependability. They're delivered promptly from a nation-wide network of plants and magazines and backed by the service of our experienced explosives engineers.

We will be pleased to serve your blasting needs.

CYANAMID

AMERICAN CYANAMID COMPANY

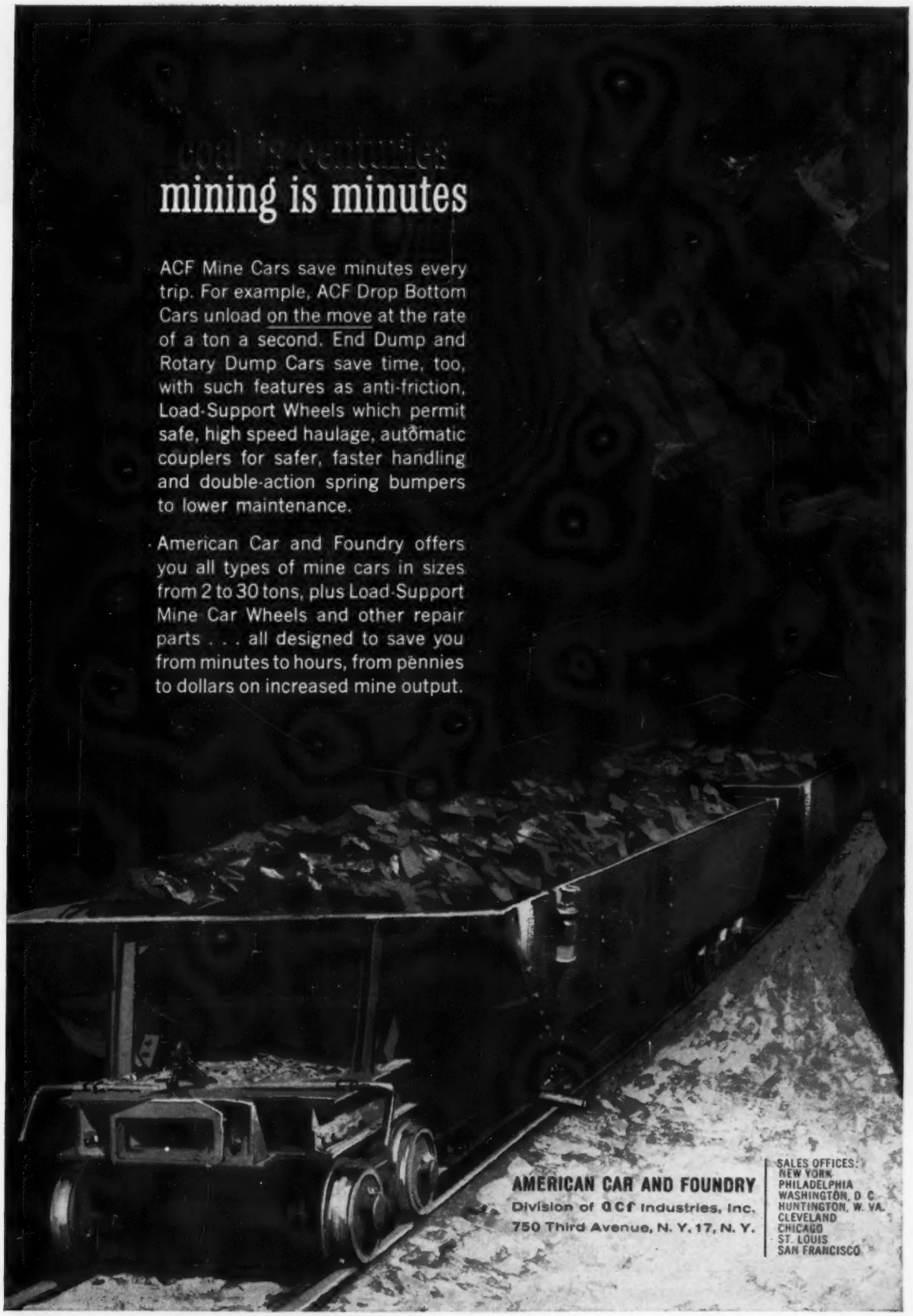
EXPLOSIVES AND MINING CHEMICALS DEPARTMENT

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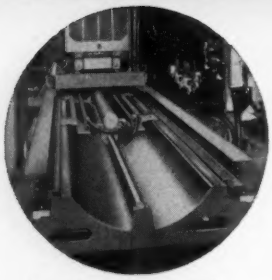
SALES OFFICES: Denver, Colorado • Maynard, Massachusetts • Kansas City, Missouri • St. Louis, Missouri • Albuquerque, New Mexico New York, N.Y. • Tulsa, Oklahoma • Latrobe, Pennsylvania • Pottsville, Pennsylvania • Dallas, Texas • Salt Lake City, Utah • Bluefield, West Virginia

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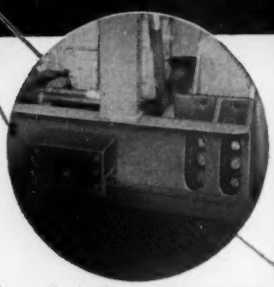
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mining is minutes
ACF Mine Cars save minutes every trip. For example, ACF Drop Bottom Cars unload on the move at the rate of a ton a second. End Dump and Rotary Dump Cars save time, too, with such features as anti-friction, Load-Support Wheels which permit safe, high speed haulage, automatic couplers for safer, faster handling and double-action spring bumpers to lower maintenance.
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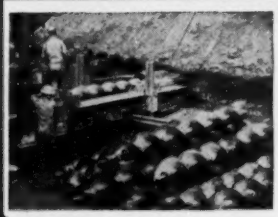
SELF-MOVING



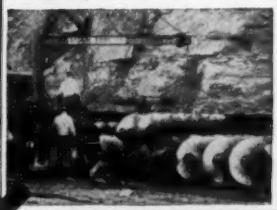
Double-acting hydraulic cylinders provide direct drive and maximum thrust to drilling head.



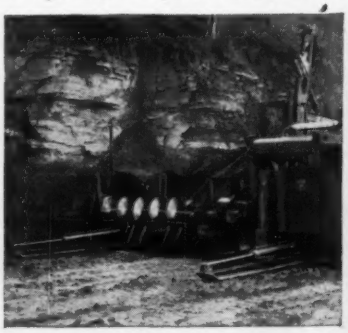
Cam rollers on engine carriage permit smooth forward and reverse travel.



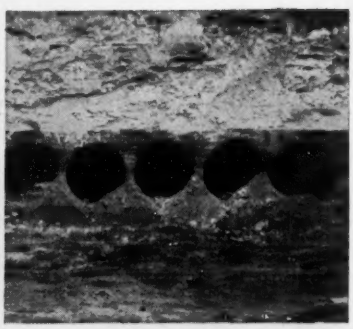
Handles three different auger sizes by simple rearrangement of adjustment blocks. Two men do complete job in one hour.



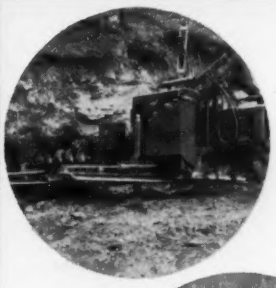
Hydraulic skids and jacks "walk" drill into position. Unit moves forward, back, left or right under own power. Placement is exact. Recovery is higher.







COAL AUGER







Conveyor arrangement permits discharge to left or right. Conveyor can be turned around easily in the field. Narrow bench or restricted pit entry is no problem.

maximum recovery ... two-man crew

No matter how you mine it, 160,000 tons per year is a lot of coal... particularly if it's done with one piece of equipment and a two-man drilling crew. That's the kind of production being reported by users of Salem's big, rugged McCarthys. The only other piece of equipment on most of these jobs is ONE dozer and operator for face up and clean up.

Coal runs faster because the McCarthys move under their own power on skids and jacks... even in wet, muddy pits. Many operators keep right on drilling in ice and snow. They stop only when haulage roads become too bad for travel.

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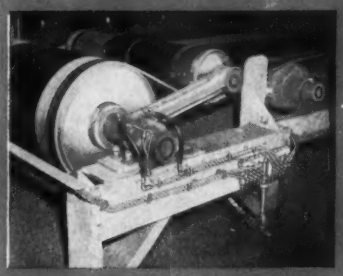


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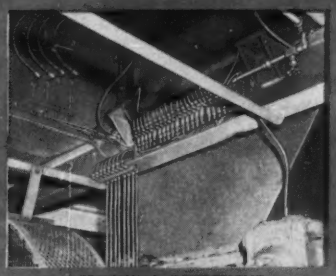


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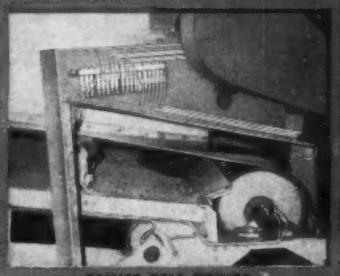
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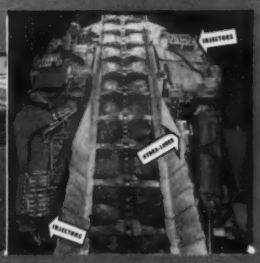


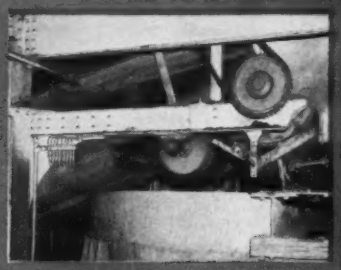
CRUSHING EQUIPMENT



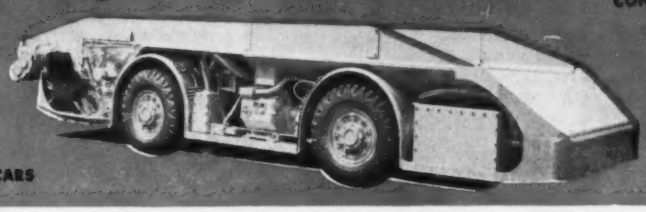
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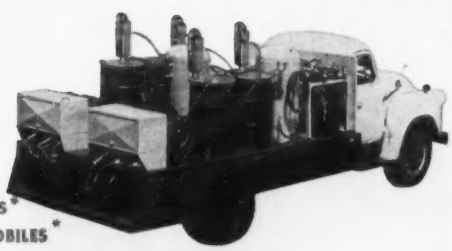


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News Roundup

Pittsburg & Midway Maps Southwestern Expansion

Kansas-based coal firm signs agreement with big Arizona utility to supply coal for new power plant.

THE Pittsburg & Midway Coal Mining Co., Pittsburg, Kan., has concluded a long-term pact with the Arizona Public Service Co., Phoenix, Ariz., to provide coal for a new $19 million, 110,000-kw steam electric plant, which the big utility will build near Joseph City, Ariz.

Edwin R. Phelps, president of P&M, said the company would supply the new plant's needs from its extensive coal reserves in New Mexico. Initial mining operations will be west of Gallup, N. M., where a new open-cut mine capable of producing 1 million tons of coal annually is being prepared. The mine is scheduled to be in production by January, 1962.

Coal will be moved to the power plant by the Santa Fe R.R., which will build a spur track to the mine. This transportation facility will also make the mine's production available to other coal users, and is expected to stimulate industrial growth in the area.

New Move—The agreement with the Arizona Public Service Co. stands as the first major contract with a large-scale coal-burning power plant in the Southwest and is viewed as the beginning of a trend toward the use of coal as a dependable and economical boiler fuel in that area. "The tremendous growth taking place in the northern part of Arizona makes the Joseph City site a logical one both from the load, growth and fuel supply," said Walter T. Lucking, Arizona Public's president. "The agreement calls for the dedication of coal reserves for 35 yr. Thus, we are assured of a long-term economical fuel supply," Mr. Lucking pointed out.

Steam Plant—Construction of the electric station, to be called the Cholla Power Plant, will begin this summer with the schedule calling for completion by late spring of 1962. The facility will be on a 1,200-acre tract 3 mi east of Joseph City and will use an average of 380,000 tons of coal annually. This is equal to 1,200 tons of coal per or 13 carloads each 24 hr. The cars will be 86-ton capacity, double the size of a normal railroad car.

Half Dozen—New Mexico thus becomes the sixth state in which P&M, now in its 75th year, will be engaged in mining operations. The company now operates seven mines in Colorado, Kansas, Missouri, Arkansas and Kentucky.

Spencer Subsidiary—P&M was only recently acquired for operation as a wholly-owned subsidiary by Spencer Chemical Co. The big chemical company paid stock for the coal firm, which ranked among the top 15 coal producers of the nation in 1950.

P&M has net assets of about $20 million, it was revealed. During the fiscal year ended March 31, 1960, it mined and sold more than 4 million tons of coal, producing sales in excess of $16 million and net income of about $1,750,000.

Based on the earnings of P&M for the year, the acquisition is expected to increase Spencer's earnings by about 60c a share in 1960. Spencer announced that in view of the current outlook for the companies, it would declare a 2 for 1 stock split in the effect of a 100% stock distribution.

John C. Denton, Spencer president, in commenting on the plans, stated, "The Pittsburg & Midway Coal Mining Co. should prove to be a valuable addition to Spencer Chemical Co. A number of its principal mines are ideally located to supply coal requirements to several of our major chemical plants; its reserves and installed capacity can provide additional annual sales and income; its organization will bring to the chemical company diversified mining skills which may serve as basis for expansion into chemically related fields."

Commenting futher, Mr. Denton indicated that Spencer would continue the coal operations of P&M as a wholly-owned subsidiary without changes in operations.

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Coke Plant

A multi-million-dollar coke manufacturing plant is slated for installation near Calvert City, Ky., by the New York Mining & Mfg. Co.

Construction will start as soon as contracts can be awarded, J. B. Taggart, vice president of the company, said. The project is expected to be completed by Jan. 1, 1961.

Hard coal to be converted into coke will come from the eastern Kentucky and West Virginia coal fields, Mr. Taggart said. It will be shipped to the new plant by barge down the Ohio river and up the Tennessee to Kentucky Lake and the new plant.

The plant will produce high-grade chemical coke and will give permanent employment to about 50 persons. The company is planning to expand the operation even before construction starts on the plant, Mr. Taggart said.

National Carbide Co.'s Calvert City plant will be the new coke company's principal customer. National Carbide uses coke in the production of calcium carbide. The plant will be in a 480-acre site along the Tennessee River.

Construction — Two Pennsylvania firms will play important roles in construction of a 200-unit non-recovery coke oven at the new plant. The Connellsville Mfg. & Mine Supply Co., Connellsville, Pa., will design, build and install semi-automatic material-handling equipment, and Femco Inc., Irwin, Pa., will design and install remote and automatic controls for operation of the Connellsville-built equipment.

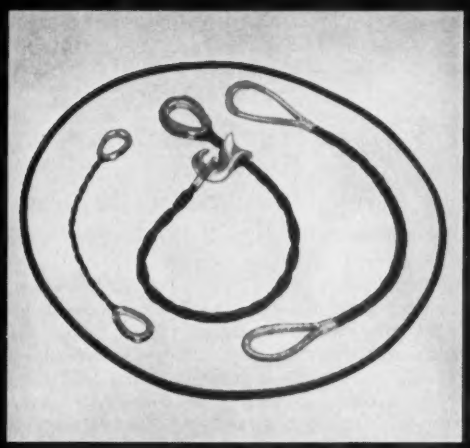
Mitchell-type ovens which combine the rectangular shape of byproduct ovens with the non-recovery simplicity of the early beehive units will be built. Connellsville will build a coke pusher, leveler, larries, conveyor quencher and

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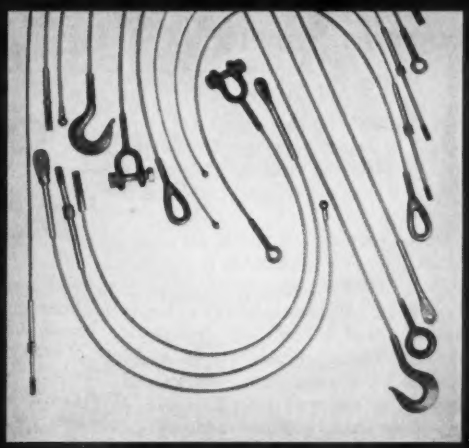
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Tops in Safety

Two underground coal mines came away with top honors in the 35th National Safety Competition sponsored by the Bureau of Mines. They were Harwick mine, Duquesne Light Co. (bituminous), and Jeddo-Highland Coal Co., Stockton, Pa. (anthracite).

The coal firms received bronze "Sentinels of Safety" trophies and green and white safety flags provided by *The Explosives Engineer* magazine. Harwick's record showed operation for 355,088 man-hours without a disabling injury. It was a first for the firm after participating in 30 previous contests. Stockton mine operated 57,329 man-hours without a disabling injury. This mine, a contestant for 18 yr, is now a two-time trophy winner. It took the top award in 1942 and ranked among the first five in its group in 1945, 1957 and 1958.

Marling J. Ankeny, director, Bureau of Mines, noted that mines and quarries in 44 states entered the 1959 competition. He added that the bureau will award certificates of achievement in safety to all injury-free mines and quarries that worked 30,000 man-hours during the year.

Beginnings—The contest, and the accompanying awards, were conceived in 1923 at a conference called by the then Secretary of Commerce, Herbert Hoover. Viewing with alarm the rising trend of accidents, many of them fatal, in the nation's mines and quarries, Mr. Hoover called a meeting to determine what could be done to reduce these persistent accidents.

The editor and staff of *The Explosives Engineer* were among those attending the conference. The magazine proposed that a competition be started to determine the mines which operated with the best safety records, and volunteered to provide a trophy to be awarded annually to the winning mines. The trophy (photo), represents a miner's wife, holding her baby, and waiting for her husband's safe return from the mine.

Entry—Any mine or quarry in the United States is eligible to enter the National Safety Competition. Contest rules and applications can be obtained from the Branch of Accident Analysis, Div. of Health and Accident Prevention, Bureau of Mines, Dept. of the Interior, Washington 25, D. C.

mud trucks. With this equipment, says Russell L. Lepley, vice president of the firm, the plant can produce 1,000 tpd of coke at a conversion cost of about 60c per ton.

Femco controls will enable an operator on the leveling machine to position larries beneath the weigh-bins for loading, move them into charging position at the ovens and unload their charges by conveyor. Other controls will be operated from the conveyor to position and operate the coke pusher on the opposite side of the oven, shift cars into position to receive the coke and move them over unloading bins, and actuate a conveyor which will carry the coke to a preparation plant for crushing.

Coal is Cheaper

An unusual legal action brought against a Minnesota gas company by an apartment house owner, who claimed he lost money by converting three heating plants from coal to natural gas, has reportedly been settled out of court in the complaint's favor.

The complainant converted three apartment buildings to gas in September, 1957, after the gas company had assured him that the changeover would save up to 25% in his fuel costs. On the

(*Continued on p 30*)

Oil Import Quotas Slashed

Interior Dept. points to supply outlook, but onlookers see pressure from coal men and domestic oil producers.

IN A surprise move, the Interior Dept. trimmed import quotas for oil, cutting the residual fuel oil limit drastically.

Under the new quotas, importers may bring in a total of 1,377,674 bbd of all types of oil and petroleum products, a reduction of 222,892 bbd from the former limit. The residual fuel oil quota was cut in half—from 490,934 bbd to 249,999 barrels. This quota, covering the heavy oil that's used mostly as ship and factory fuel, applies only to companies operating east of the Rocky Mountains. It is to be in effect from July to September. Limits on all other oil and oil products run from July to January.

Officially, the sharp reduction in the residual oil quotas was attributed to the supply outlook. However, certain government officials as well as many oil importers, said the cut at least in part reflected heavy pressures from congressmen, domestic oil men and coal producers. Coal industry sources have been pressing for a cutback, particularly in residual fuel oil, which is a direct competitor to coal.

Gratified—Stephen F. Dunn, president of the National Coal Association, commented, "The bituminous coal industry is extremely gratified that the Dept. of Interior has cut residual oil levels to a more equitable level. The coal industry has consistently maintained that heavy residual oil imports endanger national defense by making essential industry dependent on foreign fuel supplies which might be cut off.

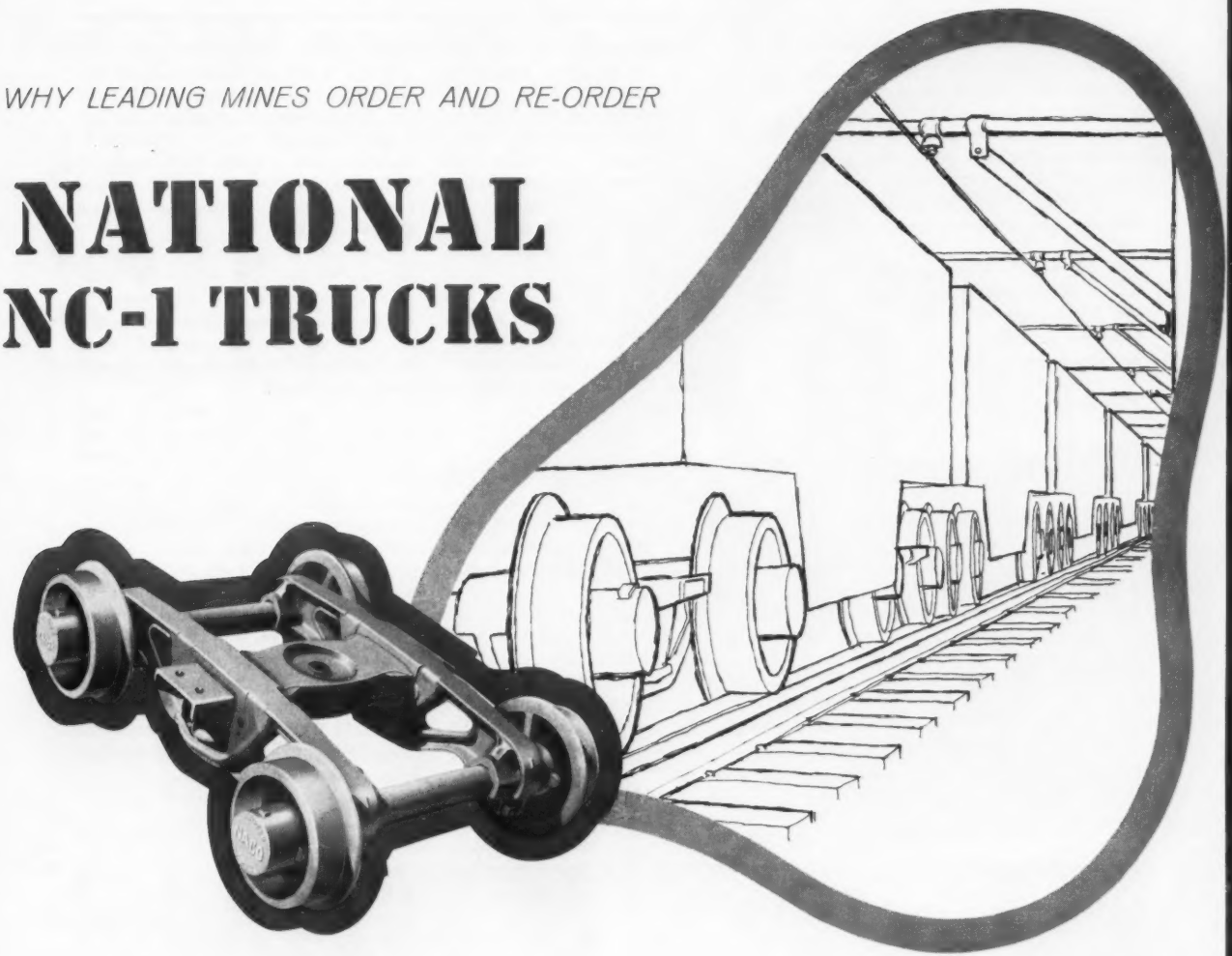
"Heavy imports of residual oil result in closing of coal mines and crippling of domestic fuels industries. President Eisenhower recognized this fact in establishing mandatory residual oil import quotas on March 10, 1959.

"In the current year international oil shippers, by cut-price competition, exhausted most of their import allocations early by luring customers away from coal. Then in order to get increased quotas they claimed that their customers were faced with shortages of fuel. We hope that the third quarter level will be continued in ensuing quarters and that the Secretary will make certain that residual oil importers will not create artificial shortages as a pretext for getting quota increases."

underground scrapers, loaders, mining machines, conveyors, car pullers, and blast hole drills.

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basis of his records, the complainant said his fuel costs actually rose 15%, indicating a 40% error in the gas company estimate.

He thereupon requested the gas firm to provide him with a rate that would bring gas cost in line with the estimate or remove the gas-burning equipment and pay him for conversion and extra fuel costs.

When the gas company took neither action, the apartment house owner filed suit for reimbursement and exemplary damages. Recently, it was reported that the gas company had agreed to settle the action out of court by payment of more than $6,000 to the owner.

Marketing Drive

The coal industry has undertaken a new "marketing crusade," Dr. Paul L. Brown, director of the Manpower Development Dept. of the National Coal Association, told the Ohio Coal Conference recently. Dr. Brown was professor of Marketing at the Ohio State University from 1946 to 1955.

One of the principal objectives in the coal campaign is to obtain new customers among industrial, commercial buildings, and institutional markets, Dr. Brown said. He explained that the effort will be directed not only at new construction but also at plants and buildings now on competitive fuel.

"Coal's advantages in price and reserves are becoming progressively important," Dr. Brown said. "Cost at the mine is within a few cents of what it was a dozen years ago. Our recoverable reserves are tremendous, with more than 40 billion tons of mineable coal available in Ohio alone."

Dr. Brown told the conference that the National Coal Association's marketing assistance to member companies includes field engineering services, air pollution control, and his own manpower development activity.

New Chemical Plant

North American Coal Corp. will build a $1 million, 40,000-ton-per-year plant to produce high-purity aluminum sulfate from coal mine wastes.

Harry G. Schmidt, North American's president, said the plant, first of its kind, would use a new process developed under a joint program with Strategic Materials Corp. The new method "is based on concepts proposed by the late Dr. Marvin J. Udy of Strategic Materials," he added.

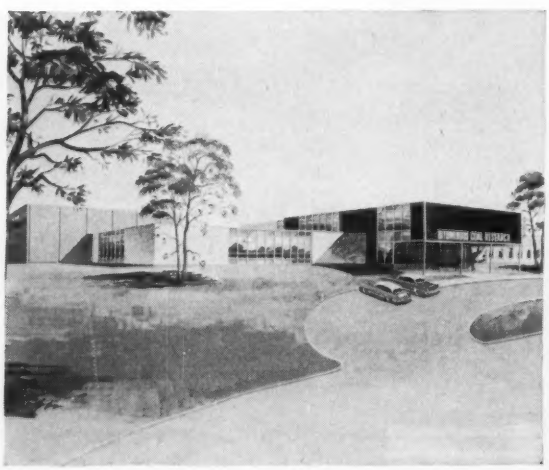
Production of high-purity alum (aluminum sulfate) is the first step in a process now under pilot-plant study for obtaining high-grade aluminum oxide from coal wastes, shales or other raw materials, continued Mr. Schmidt. Other starting materials such as high-iron clays or bauxites can be used in the new process to produce low-iron and iron-free aluminum sulfate.

Part of the initial output of the aluminum sulfate plant will be used for commercial-scale studies on the production of low-soda alumina (aluminum oxide). This type oxide will be suitable for making aluminum metal, abrasive and ceramics, he pointed out.

"The significance of successful commercial production of alumina from domestic ores is the fact that it will permit the development of a completely integrated industry for the production of aluminum metal in a preferred marketing area," Mr. Schmidt said.

The new plant is to be located at North American's Powhatan, Ohio, mine on the Ohio River where there are extensive reserves of both coal and shale. In this area, low-cost electric power is available from power plants, using coal from the company's coal mines, which also yield the shale for the alumina, he said. Initial production at the new plant is scheduled for June, 1961.

(*Continued on p 57*)





Bituminous Coal Research Plans Lab . . . Makes Award

BCR, now incorporated as a division of the National Coal Association, received approval from NCA's board of directors at NCA's annual meeting, June 8-9, in Washington, D. C., for construction of a new $875,000 research lab (artist's sketch). The lab would be the center of intensive studies aimed at finding new and better uses for coal.

AT THE ANNUAL NCA meeting, BCR presented to Dr. H. J. Rose (center), who announced his retirement as consultant to the organization, an award for outstanding leadership and service. Dr. A. A. Potter (left), who retired as president of BCR, makes the presentation, while Stephen S. Dunn, recently elected president of NCA, looks on.

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People in Coal



Up The Ladder

CHARLES B. TILLSON JR., formerly assistant manager for Crucible Steel Co.'s Fuel Div., has been named manager, raw materials, for the firm. In this new position, he will provide planning, analysis, coordination, and will establish policy for all coal activities.

Mr. Tillson joined Crucible in 1952 as assistant superintendent at the company's coal mine in Crucible, Pa. He was appointed superintendent of the mine in 1953 and general superintendent in 1955. He became assistant manager of the Fuel Div. in 1958.

A native of Wayland, Mass., Mr. Tillson received a BS degree in mining engineering from Lehigh University. During World War II he served on the Solid Fuels section of Supreme Headquarters staff in Europe. Before coming to Crucible, he spent 15 yr with Bethlehem Mines Corp.

Mr. Tillson is a managing director of The Coal Mining Institute of America, and a member of the Pittsburgh Coal Mining Institute, the Mining Electro-Mechanical Maintenance Association, Kanawha Valley Mining Institute and AIME. He and his wife live with three children in Mt. Lebanon, Pa.



G. L. Judy



D. H. DAVIS

Changes Made in Consolidation Coal Organization

George L. Judy, formerly vice president, Mountaineer Coal Co. Div. of Consolidation Coal Co., has been named vice president-operations, for Christopher Coal Co., another Consol subsidiary. Mr. Judy came to Mountaineer in 1945 as division maintenance superintendent after serving with the DuPont Co. as an engineer. He became superintendent of various mines, was made general superintendent in 1952 and became vice president of Mountaineer in 1953, holding that position until this new appointment. He is an alumnus of West Virginia University, College of Engineering, and a director of the Northern West Virginia Coal Association.

David H. Davis is the new vice president-operations, for Mountaineer Coal, with headquarters at Monongah, W. Va. For the past 2 yr he has been assistant to the vice president-operations, of Consolidation Coal. He is an alumnus of Ohio State University with a degree in mining engineering and did graduate work in fuels metallurgy. His career included 10 yr as preparation manager and chief chemist for Pittsburgh Coal Co. Div., service as division superintendent of mines for Pittsburgh Coal, and 6 yr as vice president of Mathies Coal Co.

Charles R. Nailler was named vice president—operations for Consolidation Coal Co. For the past 7 yr Mr. Nailler has been president of Christopher Coal Co., Morgantown, W. Va., one of Consol's operating subsidiaries. He graduated from Case University in 1932 and the following year went to work for Hanna Coal Co. in St. Clairsville, Ohio. At the time Hanna Coal was acquired by Consol, he had become general manager of mines and in 1946 he was transferred to Christopher Coal Co. as vice president. Mr. Nailler will continue to make his headquarters at Morgantown, a point centrally located with respect to Consol's mining operations.

Harold Suter, presently vice president of Christopher Coal Co., will succeed Mr. Nailler as president of that organization. Mr. Suter was superintendent of Pursglove Coal Mining Co. when Consol



Style GR, cylindrical insert



HR Style, 1½" gage stop



JN for continuous miners



HJN recovery auger bit



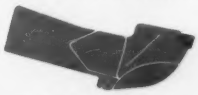
G Style, straight shank



Style GN, notched shank



JC Colmol and Boring bit



GV, for Joy GV-6111 chain



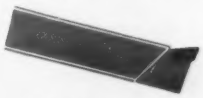
KN Style, chisel-nose tip



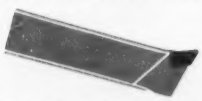
HN Style, 1½" gage stop



Style A straight shank



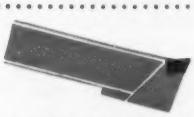
Style C for impurities



Style D for coal, potash, salt



Style E for Goodman Borers



Style CC, milled shank



L Style for Bowdil ML chains

CARMET OFFERS 25 STYLES OF MINING TOOLS

for every condition you have

Carmet carbide mining tools get high-tonnage production because they're precision made to meet specific mining operations. Hard, tough grades of carbide are induction brazed to high alloy, heat treated shanks in a way that insures maximum tool life. Cutter bits are designed for shortwall, longwall, universal machines and continuous miners of every make. Drill bits drill clean, straight holes at fastest speeds. Carmet distributors keep a complete line of Carmet Mining Tools in stock for prompt delivery. Carmet field engineers are always on call to help you solve tool problems and cut mining costs. Take advantage of their know-how now.

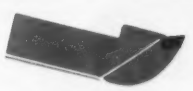
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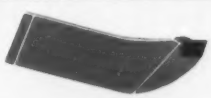
The newly revised 5th Edition of the Carmet Mining Tool Catalog contains application data and specifications on the complete line of Carmet Mining Tools, including a complete section on grinding and reconditioning. For your copy, write Carmet Division, Allegheny Ludlum Steel Corporation, Detroit 20, Michigan.



ADDRESS DEPT. A-7



N Style special clearance bit



O Style for rotary head miners



R Style finger bits



Style UL coal drill



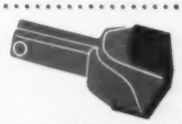
Style VL drill bit



W Style for friable seams



WW Style, power and hand drilling



T and TT Styles for roof bolting



S and SS Roof Bolting drills

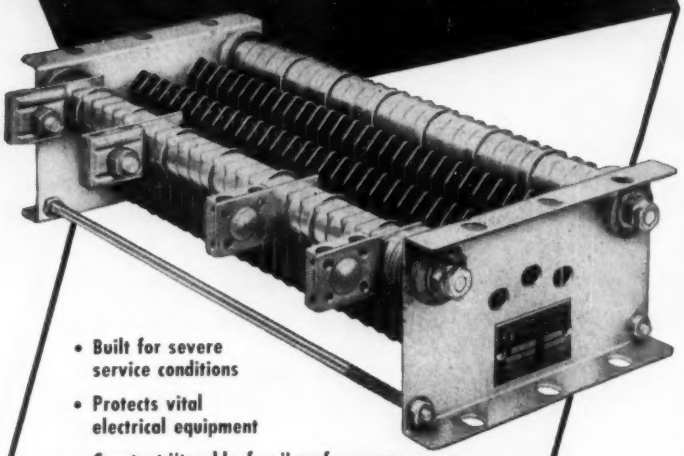
The Original DOUBLE-BONDED Carbide Cutter Bit

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7269

P-G Steel Grid Resistor
plays an *essential part*
in the production of COAL . . .

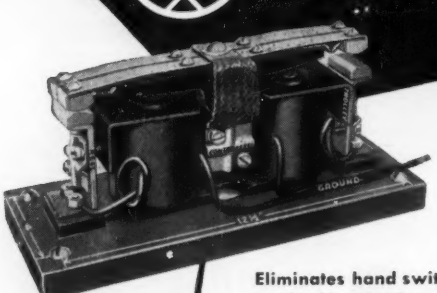


- Built for severe service conditions
- Protects vital electrical equipment
- Constant "trouble free" performance

These rugged nonbreakable units have proved their merit in all kinds of service for many years. Made of steel and mica, plus P-G unique and exclusive grid design, P-G Resistors are capable of protecting your most vital electrical equipment, even where service requirements are severe.

Designed to fit your present resistor space

P-G AUTOMATIC Transfer Switch



Single or double trolley and reel

Eliminates hand switches—entirely automatic. No shocks or burns to operator while changing from trolley to reel. Simple, safe, efficient, easy to install, can be mounted anywhere. For 250 to 600-volt service. Complete with cover.

P-G

THE POST-GLOVER ELECTRIC COMPANY
OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky
MAILING ADDRESS Box 709, Covington, Kentucky

People in Coal (*Continued*)

acquired that company in the early forties. He later became general superintendent of Christopher and its vice president in 1956.

Pete Spragg retired from his position as chief mine inspector for Consolidation Coal Co.'s Mountaineer Coal Co. Div. He had been with Consol 50 yr, joining them in 1910. During his career he served as section foreman at Mine Nos. 26, 32, 38 and 63, moving up to superintendent of Mine No. 97 in 1942. When that mine closed in 1953 he became a mine inspector for the Fairmont Div. He served an interim appointment as superintendent of Mine No. 63 for a short period, then advancing to chief mine inspector.

Other changes in the Consol organization included transfer of **William O. Barnard,** formerly general superinterdent, Christopher Coal, to Mountaineer Coal as general superintendent of Mine 32 and Mine 63, at Monongah. A native of Morgantown, W. Va., Mr. Barnard was graduated from West Virginia University in 1943 with a degree in mining engineering. He joined Christopher in 1946 and advanced from assistant mine foreman to general superintendent. He is a registered professional engineer, member of AIME and past president of the Monongahela Valley Coal Mining Institute.

Consol also announced that **William N. Poundstone**, formerly superintendent of Humphrey No. 7 mine, has been named general superintendent of Christopher, with offices in Osage, W. Va. Mr. Poundstone was born in Morgantown and graduated from West Virginia University in 1949 with a degree in mining engineering. He immediately joined the Christopher organization, and progressed through various engineering and supervisory positions until his appointment as superintendent of Humphrey No. 7 in 1955. Replacing him as superintendent of that mine is **Mark Sansone,** formerly assistant superintendent.

Mountaineer Coal Co. Div. announced four other changes: **Richard C. McCandless** was appointed superintendent, Consol No. 32; **Gene D. Shockey** was named superintendent, Consol No. 63; **C. E. Herndon** was named maintenance foreman, Consol No. 63; and **William T. Hylton** was appointed maintenance engineer, Consol No. 32.

Harry A. Crichton, Westfield, N. J., president of the Johnstown Coal & Coke Co., New York 4, was honored by the Lehigh Alumni Association of Lehigh University with a distinguished service award in "recognition of loyalty and service to his alma mater and his profession." The citation read, "For a modesty which disclaims excitement in a life culminating in the presidencies of

Femco systems and products for more efficient mining

Femco, Inc. engineers and develops systems for communication, monitoring and remote control which meet the rigorous requirements of the mining industry. Standard systems, together with certain other Femco products, are summarized below. We are prepared not only to supply the systems listed but also to develop special systems for other mining applications.

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Trolleyphone 3000—Newest model of the first practical mine communication system for use between moving and stationary locations. Microphone and loudspeaker conversation. Carrier system utilizes existing lines.

Loudspeaking Mine Telephone—Communication between fixed points underground. Two-way loudspeaker paging saves time—brings you into immediate contact. No ringing station after station. System is battery powered, 100% transistorized.

Wired Audio Systems—For cleaning and preparation plants, and for surface supervisory personnel. Paging over wide areas. Special four-wire communication cable. Handsets or integral microphones. Desk and paging stations available.

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(East of the Mississippi, all Femco mine communication systems are distributed by National Mine Service Company.)

Monitoring and Remote Control Systems

Femco 709—Monitors fans and circuit breakers; automatically cuts off power into mine in the event of fan failure; provides selective control of all circuit breakers from a central point. Requires a single two-wire parallel circuit.

Pump Monitoring and Control—Provides centralized indication and control of pump operation. Requires a two-wire parallel circuit, which may be integrated with circuit for Femco 709 system.

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Femco 10-Shot—Capacitor operated, assuring adequate energy output. Bureau of Mines Approval #1603.

New 20-Shot—Manufactured by Femco for major powder companies. No "weak" shots—special safety circuit prevents firing unless capacitor is fully charged. If operation is stopped after charging starts, charge is drained from the capacitor—cannot enter wires. Bureau of Mines Approval #16D-9.

Mine Lights

Femco Fluorescent System—To illuminate working areas between the face and the loading head. Dust-proof, completely portable units give excellent illumination at low cost. Approved by Bureau of Mines for gassy atmospheres.

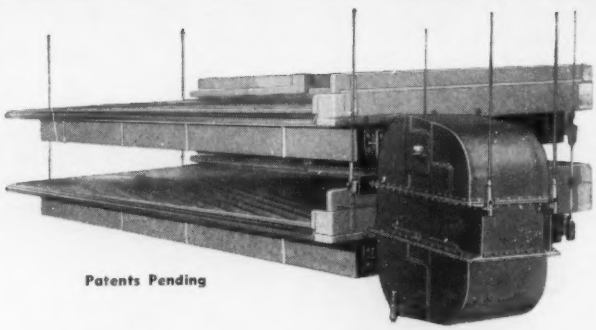
We will be pleased to send you full information on any of these systems and products, or to discuss any special problems of communication or remote control.

A-200

Femco, Inc., Irwin, Pennsylvania

Femco

COMMUNICATIONS: Carrier and wired audio systems for all mining and industrial applications. **MONITORING:** Fans, circuit breakers, valves, pumps, compressors, etc. **TELEMETERING:** Flows, pressures and other functions. **REMOTE CONTROL:** Pumps, valves, circuit breakers, soaking pit covers, furnace doors, cranes, or other moving equipment.



Patents Pending

Double Your Fine Coal Production in Any Unit of Floor Area

By installing CONCENCO® 77 twin deck tables in the space now occupied by your single deck tables you can double capacity in that plant area and at the same time make important savings in cleaning costs.

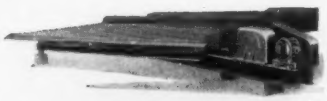
The twin decks are synchronously actuated by a single novel head motion using a motor of exactly the same horsepower required for the single deck table. The power saving is obvious.

A further economy is effected by halving the piping and wiring required for feeding and servicing the tables.

By installing CONCENCO 77 tables, new building expansion programs may be long deferred, possibly avoided altogether. When new buildings are required, the twin decks being in floating suspension and operating with greatly reduced impact to the supporting structure, make lighter and more economical construction possible. The sum total of all these economies is substantial. For full information ask for Bulletin 77.

For Single Deck Installations, Use the SuperDuty® No. 7 Table

Where its use may be indicated, the SuperDuty DIAGONAL-DECK® Table continues to offer the same highly efficient and economical preparation of fine sizes. Special models are available in this single deck equipment also for handling high refuse feeds. For full information, simply ask for Bulletin 119.



THE DEISTER★ CONCENTRATOR COMPANY

CONCENCO PRODUCTS

★ *The ORIGINAL Deister Company* ★ *Inc. 1906*

909 Glasgow Ave. • Fort Wayne, Ind., U.S.A.

People in Coal (*Continued*)

at least three companies; for self-effacement which claims no credit for public service as a director of Rahway Memorial Hospital, and as a worker in his church and on drives for the Red Cross, the YMCA, and other charitable institutions; and for a quiet loyalty which claims no credit for his life-long interest in and generous support of his alma mater, the Lehigh University Alumni Association happily confers upon Harry Allen Crichton its highest award."

J. A. Hunt was elected chairman of the board of the New River Co., and **W. A. Haslam** was chosen president. Mr. Hunt was president of Lillybrook Coal Co., the New River Co., and Winding Gulf Coals. Mr. Haslam will continue as president of Winding Gulf Coals.

George O. Tarleton has been elected president of the Western Pennsylvania Coal Operators Association, succeeding **G. A. Shoemaker,** who has served more than 9 yr. Mr. Tarleton is president of the Pittsburgh Coal Co., Div. of Consolidation Coal Co. Other officers elected at the annual membership meeting of the association were: **Charles B. Baton,** vice president; **Harry A. Sutter,** executive vice president; **M. C. Briggs,** treasurer; and **Earl Glass,** secretary.

At the annual meeting of the Dawson-Daylight-Collieries, a group of companies headed by Joseph H. Schneider, **Walter A. Morris** was elected president and **Victor C. Roerk** executive vice president of the Dawson Coal Co. and Dawson Coal Sales Co. **Mr. Schneider** was elected chairman of all the companies and **William A. Borries** was reelected president of the Dawson Daylight Coal Co., Dawson Collieries and the Daylight-Collieries Store Cos.

Samuel F. Stepp has been named staff engineer of the Bituminous Coal Dept. of the National Coal Association. Mr. Stepp will be assigned to the Washington office of BCI, which is part of NCA's Marketing Div. He is an engineering graduate of the South Dakota School of Mines and was formerly employed by the State of Minnesota as assistant director of public property. He is a registered engineer and a member of the Minnesota Society of Professional Engineers.

The Mid-West Coal Producers Institute, Inc., has elected **Frank Nugent** president of the institute to fill the vacancy created by the resignation of S. L. Jewell. For the past several years, Mr. Nugent, who is president of the Freeman Coal Mining Corp., has served

(*Continued on p 68*)

NEW from Cummins!
Only from Cummins!

The first V dieselsof their size and h.p. built from the pan up for cons

V

V

T 8.430 h.p.

nstruction machines!

I 8.350 h.p.



V8-430

Cummins has done it again! Built two V diesels in the much needed 350-430 horsepower class especially for construction machines. This opens a new world of *Cummins Diesel economy* for big scrapers, off-highway trucks, shovels, front end loaders and other equipment where there has been a demand for compact yet large bore, big displacement engines.

The 350 h.p. and the 430 h.p. V8 engines are construction diesels from front to back, top to bottom. Every kind of application—every operating condition was considered in their design. The V8's represent the *most advanced* thinking in construction power on the market today! New features, major improvements combined with Cummins proven basic design makes them the most profitable source of power you can own or operate! And here's why...

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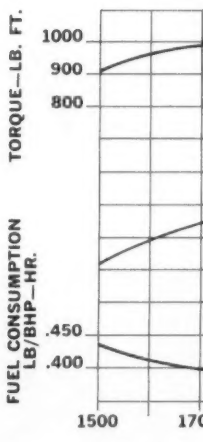
THE DIESEL
ANCE OF ENG

430 horsepower!
displacement! 7
Put these fact
Cummins VT8-4
that's as much
engines in curre

From its ver
give you the be
turbocharging p
assures full rated
engineers have de
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Cummins pu
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accessibility, eas
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All in all, th
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operating life as
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Curves represent perfor

Litho in U.S.A. — MP-60

EL THAT DELIVERS THE PERFORM-
ENGINES WITH *4 MORE CYLINDERS!*

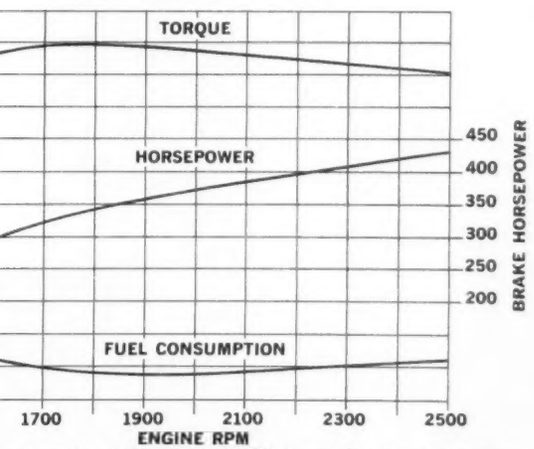
wer! 990 ft. lbs. peak torque! 950 cubic inch
t! 7 lbs. per h.p.! Less than 59 inches long!
facts together and you have the rugged
T8-430 TURBODIESEL® Engine—the diesel
uch as 40% smaller and more compact than
urrent use delivering equal power.

very concept, the VT8-430 was designed to
e benefits of turbocharging. Not only does
ng pack more power into the engine, but it
rated horsepower up to 10,000 feet. Cummins
ve developed a lightweight, perfectly-balanced
r that gives fast acceleration—trouble-free
. Further, the VT8 operates at low exhaust
s assuring long life for both the engine and
r.

s puts the accessories on top of the block, in
ned by the cylinder banks. This means greater
easier maintenance, less costly repairs. In-
insert-type injectors are much easier to install
Wet-type liners require less time to remove,
install. These are only few of the many
of this new Cummins Construction Diesel.

l, the VT8-430 gives you a combination of
nance, low fuel costs (see chart below), long
e as well as a lower initial investment than the
es in its power class. You can't beat this
omy!

VT8-430 PERFORMANCE CURVES



erformance at altitudes to 10,000 ft. with 90° F intake air temp.

V8-350

NEVER BEFORE, SO MUCH POWER FROM SUCH A COMPACT, NATURALLY-ASPIRATED DIESEL!

Here's rugged construction power! 805 ft. lbs. peak torque —*naturally!* (See curves below.) Like the VT8, this engine has a piston displacement of 950 cubic inches and rotates at 2500 rpm. This produces 350 horsepower in a package that's less than 57 inches long.

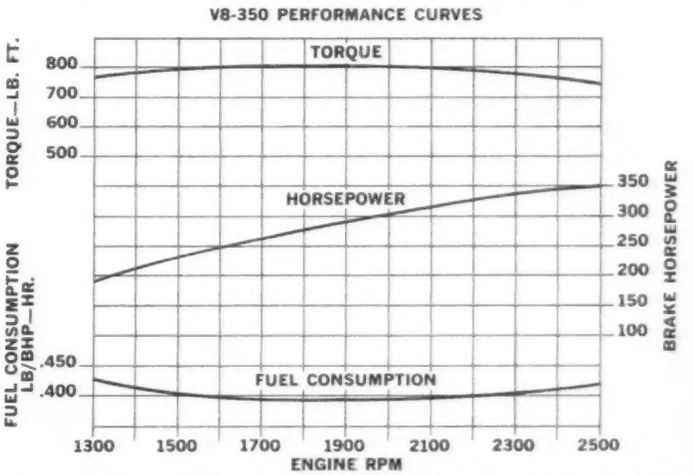
The V8-350 has many new features to reduce operating costs. New internal fuel and oil lines eliminate threaded connections, damage to exposed lines. Cummins own 12 cfm air compressor is supplied on both engines. Of simple, one cylinder design, here is the only unit in the trade backed by a 3600 hour or one year warranty.

Another practical advantage of the V8 Diesels is the 2500 rpm. This gives you an ideal relationship of horsepower, torque and speed to permit the use of lighter, more compact, less costly transmissions. In other words, your initial investment is reduced as well as the maintenance cost during operating life.

Cummins exclusive PT fuel system also reduces maintenance and fuel costs. It operates on lower priced No. 2 diesel fuel . . . has fewer parts than any other diesel fuel system. The pump is mounted in the 90° angle formed by the cylinder banks. Also possible, on the V8-350 . . . either the intake or exhaust manifold can be placed inside the "V" to fit your application requirements.

Get the complete profit-making story on these new compact V diesels, and on the models in which they are available, from your nearest construction equipment representative or Cummins Distributor.

V8-350 PERFORMANCE CURVES



Ratings corrected to conditions of 29.92" hg (sea level) barometric pressure; 60° F intake air temp.

STAY OUT OF THE MUCK

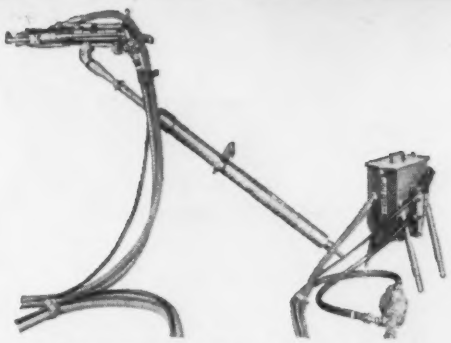
NOW—Dust-free drilling without water!

...with the Le Roi LLV Dust-collecting Air Leg Drill

You'll drill fast, dry, and clean through the hardest rock with the new Le Roi LLV Dust-collecting Air Leg Drill. It outperforms wet-drilling machines and has a much lower dust count — you don't use a drop of water in the mine or tunnel.

The LLV's efficient dust collection keeps holes clean for faster, deeper penetration — prevents stuck steels and lost holes. Its powerful suction removes cuttings through the hollow drill steel and out the side of the chuck housing. *None* passes through the machine. Results: less maintenance and longer tool life.

Ask your Le Roi distributor for a demonstration. Or write Le Roi Division, Westinghouse Air Brake Co., Milwaukee 1, Wisconsin.



DRY "DUSTLESS" LLV collects cuttings in LX-1 dust box. Operator can empty box by remote control lever on drill.

LE ROI NEWMATIC® AIR TOOLS

Distributed in the Coal Fields by: Acme Machinery Company, Huntington, West Virginia, and Equipment Service Company, Inc., Birmingham, Alabama.

AT-906

Current Coal Patents

By: Oliver S. North

Method and apparatus for splicing electrical mining cable, C. R. Nailler and W. B. Jamison (assigned to Consolidation Coal Co.), May 10, 1960. Method and apparatus for splicing electrical mining trailing cable so that the finished splice will have substantially the same diameter, flexibility, electrical conductivity, and tensile strength as has an equal length of unspliced cable. No. 2,936,257.

Method of and apparatus for carrying coals out of a vertical shaft with the aid of heavy liquid in the coal mine, H. Osawa, May 17, 1960. In a novel method for raising coal in a mine, a small vertical or inclined borehole sunk to seam level is filled with a heavy liquid. Mined coal is fed into the liquid column through valves and is buoyed up to the surface, where it is recovered. The heavy liquid used is a dispersion of silt and a pulverized heavy material, such as pyrite cinder, hematite, limonite, magnetite, ferro-silicon, galena, or the like. No. 2,937,049.

Mining machine having extensible and retractable boring arm, A. B. Jackson (assigned to National Mine Service Co.), May 24, 1960. In a mining machine carrying tools on an arm rotating around an axis normal to the face being cut, a fluid-pressure device is provided for extending and retracting the arm while it is being held in extended position by a positive support independent of the fluid-pressure device. The entire mechanism is embodied in the arm, thus being protected from damage by debris resulting from the cutting operation. No. 2,937,859.

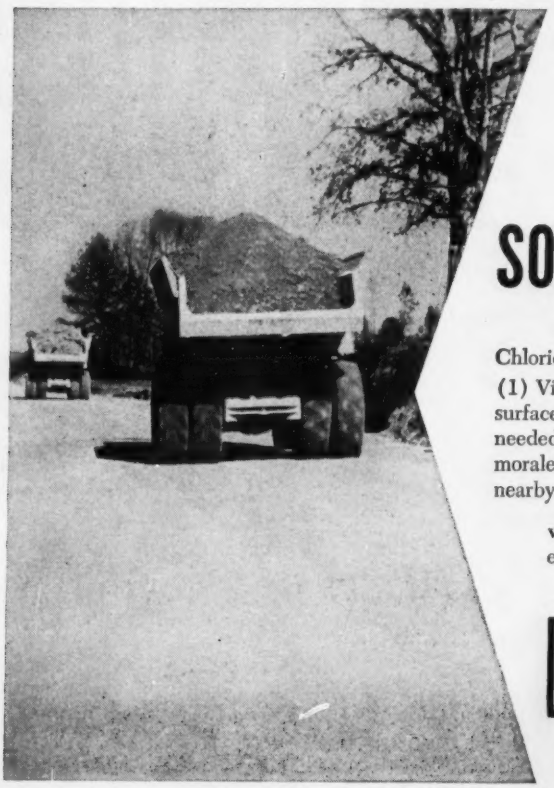
Coal carrying apparatus, T. Nogami, May 31, 1960. Design for an apparatus for direct fluid transportation of coal from a mine to the surface by employing water under pressure directed from the surface into the mine and back with an auxiliary air-pressure hook-up used as secondary lifting means. The coal is fed into the stream of water by charging coal-tanks while off stream. No. 2,938,751.

Rotary cutting head having core burster means, W. N. Poundstone (assigned to Consolidation Coal Co.), June 7, 1960. Design for a rotary cutting head for use with a continuous mining machine which cuts circular kerfs in a vertical face of coal. The head has an improved core burster for breaking down and dislodging the cores of coal. No. 2,939,690.

Continuous mining apparatus of the chain type for longwall mining, J. A. Russell and J. R. Bouille (assigned to Joy Mfg. Co.), June 7, 1960. Balanced design for an apparatus for use in the mining of coal by longwall methods, whereby greater stability in operation is obtained. The machine has a novel head structure and an improved power swinging arrangement, is compact, and its parts are readily accessible for inspection and maintenance. No. 2,939,692.

Tubular Galleries

Commenting on the June, 1960, *Coal Age* feature entitled "U.S. Steel Opens Maple Creek Project," R. J. Niebanck, Engineering & Development Dept. Div. of Air Reduction Co., Inc., points out that Maple Creek was not the first to use tubular steel conveyor galleries, as stated in that feature. "We have had prefabricated steel tubular conveyor galleries (engineered by the Link-Belt Co.) since January, 1959, at our Calvert City (Ky.) operations, and we believe Link-Belt will confirm two or more earlier aluminum and steel installations elsewhere."



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SOLVAY CALCIUM CHLORIDE

It *pays* to end dust on haulage roads with SOLVAY® Calcium Chloride, for five good reasons.

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GOLD LINE

The ORIGINAL PVC MINE BELTING

First in the mining field, first in sales and performance, Scandura is the solid-woven polyvinyl chloride belting that made all the records in the beginning . . . and is building the most today! Months and years of experience on some of the most difficult applications ever assigned to conveyor belting give the crown to *Scandura* —the lighter weight, flexible, oil resistant belting certified fire resistant, immune to ply separation, mildew and rot under the worst conditions. Scandura Gold Line holds the cost line, too! See your National Mine man for quotations on your needs.

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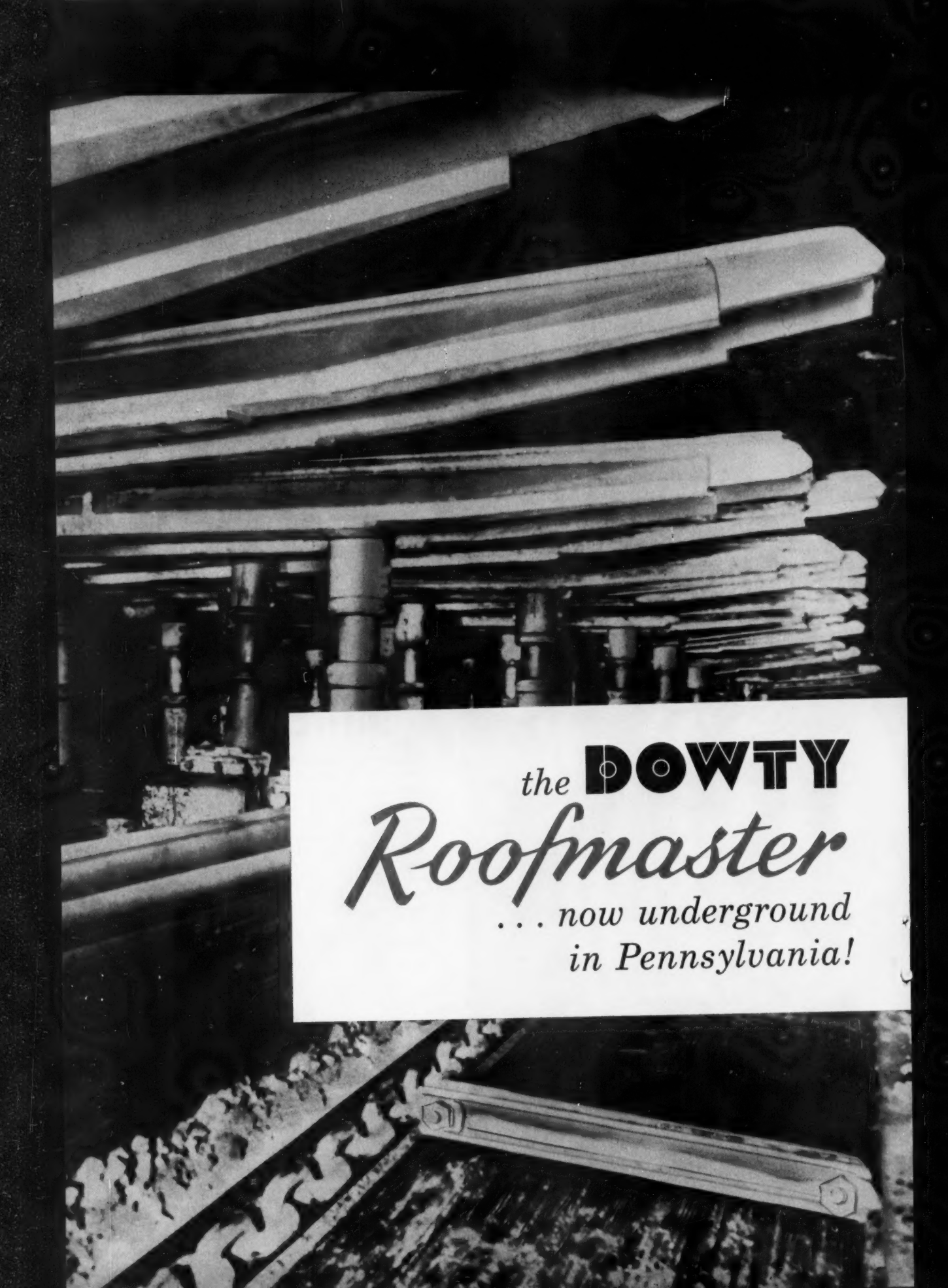
KY.-VA. DIVISION
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WESTERN DIVISION
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WESTERN KY. DIVISION
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Indiana, Pa.


the DOWTY
Roofmaster
. . . now underground
in Pennsylvania!

400 ft. longwall face mined with fully mechanized "push button" roof control system

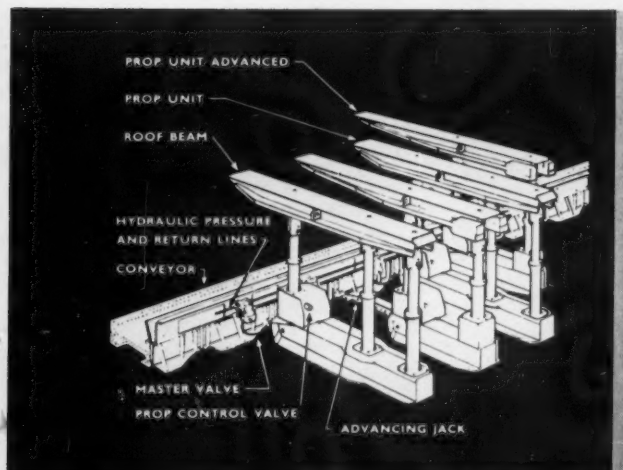
The DOWTY *Roofmaster* is now making *practical* all the "theoretical" advantages of *longwall mining* . . . positive, continuous operations . . . no moving from place to place . . . concentration of output and haulage . . . simplicity of ventilation . . . *high output per man and low cost per ton.*

The new production-boosting *Roofmaster* system is now operating on a 400-ft. longwall coal face in Central Pennsylvania. It is a self-advancing, hydraulic-powered roof support system used with a shearer continuous miner and snaking conveyor.

With the *Roofmaster* system, *all functions* of roof control on the longwall face are performed by two men! The total face crew of five to seven men is expected to produce 600 or more tons of coal per shift on a 3½-ft. seam.

Conditions throughout bituminous areas are favorable for conversion to longwall with the DOWTY *Roofmaster* system. Greater production — greater safety — greater profits . . . these are the rich rewards attainable.

Skilled and experienced DOWTY engineers are available to survey the longwall potential of your mine, and provide comprehensive reports without obligation.



The DOWTY *Roofmaster* consists of self-advancing, hydraulic-powered double and triple-prop support units. Only two men are required for continuous operation of 200 support units.

WORLD PIONEERS OF HYDRAULICS FOR MINING

DOWTY

MINING LIMITED

90 Broad Street, N. Y. 4, N. Y. • Telephone Digby 4-6876

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"Dowty Service Is Your Guarantee"

The No. 8 Ripper digs deep—rips the tough blue shale to prepare it for fast, easy loading. Blasting costs reduced 90%.



PRODUCTION UP 30%—COSTS DOWN 70%

RIPPING WITH NEW POWER SHIFT D8 SERIES H TRACTOR

The Harban Coal and Contracting Co. strips overburden at Tamaqua, Pa., the modern, economical way. A new 235 HP Power Shift Cat D8H Tractor first rips the tough blue shale then uses its blade to pushload two D8-drawn 463 Scrapers. These units work six days a week, remove between 3500 and 4000 cu. yd. of overburden every seven-hour shift.

Formerly, the company used a 5½-yard dragline for this job. However, 80% of the shale had to be blasted and, in many cases, handled two or three times. Use of the ripper-equipped tractor has reduced blasting 90% and the material is handled only once. Joseph Harlam, partner in the Harban Coal and Contracting Co., reports production has been boosted 30%—while costs are down 70%.

Said Mr. Harlam, "Our job is extremely hard on equipment, but we feel that Caterpillar machines are tough enough to take it. It has proven to be so." He adds, "The power shift is a great improvement and *undercarriage life on our D8s has been almost unbelievable.*"

Features on the new Cat D8H Tractor that rate high with successful businessmen like Mr. Harlam include: (1) the *full* power shift transmission with single lever on-the-go changes in speed and direction *even* under full load, (2) lifetime lubricated track rollers with exclusive floating ring seals that *never* need servicing, (3) the economy and power of the turbocharged D342 Engine.

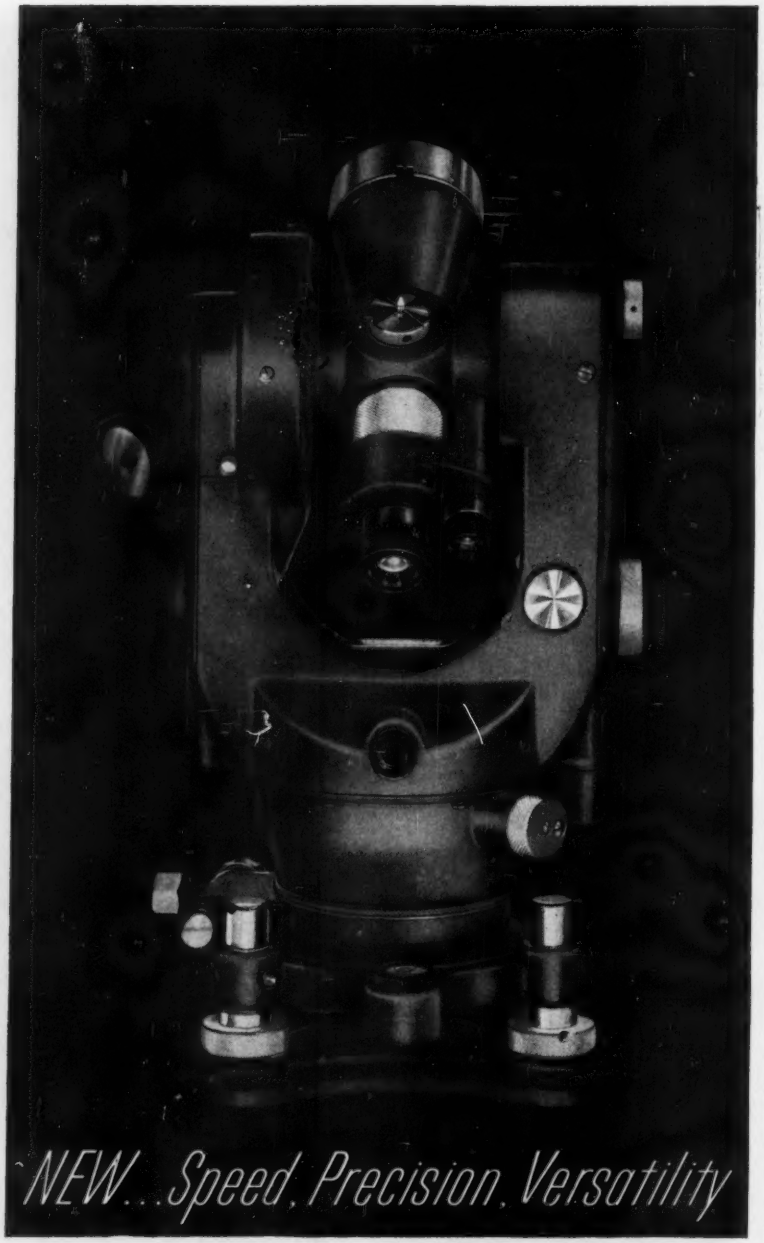
Get the whole story on how a Cat D8H Tractor can pay off on your operation. Your Caterpillar Dealer will be glad to show you with an on-the-job demonstration. Plan to see him soon.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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WILD T-1A OPTICAL REPEATING TRANSIT

All the ruggedness, simplicity, and trouble-free performance of the world renowned T-1...plus the convenience and extra speed of automatic vertical collimation setting.

Vertical angles can be read immediately after set-up. No need to center vertical circle level...no cleaning or maintaining moving parts.

Highway, mining, or any other surveying project, day or underground, becomes routine with the Wild T-1A.

Upper and lower motions for setting on zero and for repeating. Built-in optical plummet.

Write for Wild Booklet T-1A.

In Canada: Wild of Canada Ltd., 157 Maclaren St., Ottawa, Ontario

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HEERBRUGG
INSTRUMENTS, INC.
Main at Covert St. • Port Washington, N.Y. • POrt Washington 7-4643
FULL FACTORY SERVICES

Equipment Approvals

Long-Airdox Co.—Mobile bridge carrier; three motors, one 40 hp and two 5 hp, 220-/440-/550 V, AC. Approvals Nos. 2F-1554 and 2F-1554A, May 4.

Dowty Mining, Ltd. — Hydraulic power pack; two motors, each 5 hp, 440 V, AC. Approval No. 2F-1555A, May 6.

British Jeffrey-Diamond, Ltd.—Anderton shearer loader; one motor, 125 hp, 440 V, AC. Approval No. 2F-1556A, May 10.

British Jeffrey-Diamond, Ltd.—Type C-20 armored conveyor; two motors, each 50 hp, 440 V, AC. Approval No. 2F-1557A, May 10.

J. H. Fletcher & Co.—Type DMA-11C4R2 roof drill; one motor, 10 hp, 250-/550 V, DC. Approvals Nos. 2F-1558 and 2F-1558A, May 10.

Long-Airdox Co. — Type TDF-25 face drill; one motor, 25 hp, 240 V, DC. Approval No. 2F-1559, May 10.

Cabell Equipment Co. — Cabell mobile drill; one motor, 5 hp, 230 V, DC. Approval No. 2F-1560, May 11.

The Jeffrey Mfg. Co.—Type 61-AMC chain conveyor; one motor, 50 hp, 440 V, AC. Approval No. 2F-1561A, May 12.

National Mine Service Co., Greensburg Div.—Four-ton diesel locomotive with a Caterpillar Tractor Co. Model D311H diesel engine for use in noncoal mines. Approval No. 24-31, May 19.

National Mine Service Co.—Type 60-60 TorKar shuttle car; one motor, 75 hp, 250 V, DC. Approval No. 2F-1562, May 23.

Acme Machinery Co. — Model 275A4JRA air compressor; one motor, 65 hp, 550 V, DC. Approval No. 2F-1563A, May 23.

Schroeder Bros. Co.—Type RC-1 roof-drilling machine; one motor, 20 hp, 440 V, AC. Approval No. 2F-1564A, May 24.

The Long Co.—Type TDF-10 face drill; one motor, 5 hp, 550 V, DC. Approval No. 2F-1474A, May 24.

July Extra . . .

Starting on p 193 this issue you will find your **Guidebook.** Refer to it often. It is your key to better mining practices.

FALK

...a good name in industry

QUALITY GEAR DRIVES and FLEXIBLE SHAFT COUPLINGS

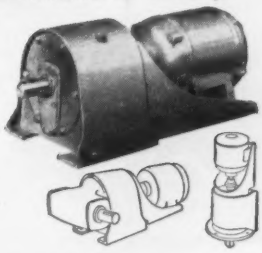
THE FALK CORPORATION, MILWAUKEE 1, WIS. *Representatives and Distributors in many principal cities.*

● The helical and spiral bevel gears in Falk gear drives assure maximum mechanical efficiency attainable—98½% per gear mesh under full load.

ALL-MOTOR MOTOREDUCERS *up to 75 hp.*

All-steel units for use with any NEMA foot-mounted motors within rated capacities of the gear drives. Standard output speeds from 1 to 780 rpm (with 1750 rpm motors); as low as .032 rpm in semi-standard designs. Also Integral units, from 1 to 40 hp.

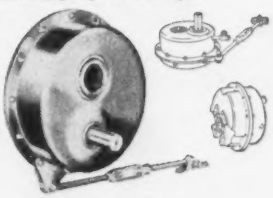
Ask for Bulletin 3100.



SHAFT MOUNTED DRIVES *up to 50 hp.*

All-steel units, horizontal or vertical. Output speeds between 420 and 5 rpm. Maximum torque rating at low speed shaft: 44,000 lb-in. Consult Factory for higher capacities and for flange mounted drives.

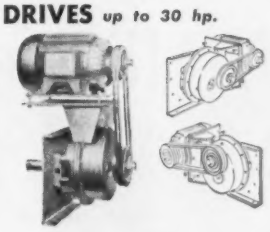
Ask for Bulletin 7100.



SCREW CONVEYOR DRIVES *up to 30 hp.*

Bolt to any standard trough end. Output speeds from 420 to 5 rpm. Max. torque rating at low speed shaft: 21,400 lb-in. Drive includes removable drive shaft and seal housing with choice of seals. Trough end and Motor Mount optional.

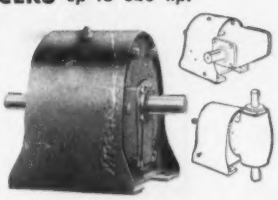
Ask for Bulletin 7106.



SMALL SPEED REDUCERS *up to 350 hp.*

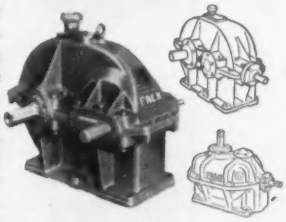
Concentric Shaft reducers with ratios from 1.49:1 to 970:1. Maximum torque at low speed shaft: 84,000 lb-in. **Right Angle** ratios from 5:1 to 1460:1. Maximum torque at low speed shaft: 73,000 lb-in.

Ask for Bulletin 1105.



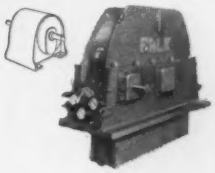
LARGE SPEED REDUCERS *up to 3500 hp.*

Parallel Shaft up to 3500 hp. Ratio range: from 2:1 to 300:1. Maximum catalog torque at low speed shaft: 1,950,000 lb-in. Bulletin 1110. **Right Angle Horizontal** up to 1000 hp. Ratio range from 1.5 to 515:1. Max. catalog torque at low speed shaft: 569,000 lb-in. Bulletin 2105. **Right Angle Vertical** up to 760 hp. Ratio range from 6:1 to 430:1. Max. catalog torque at low speed shaft: 714,000 lb-in. Low speed shaft extension up or down. Bulletin 2110.



HIGH SPEED DRIVES *... reducers or increasers.*

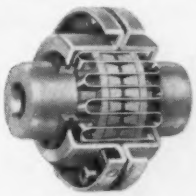
Parallel Shaft drives cataloged up to 5,000 hp or 10,000 rpm. Unit ratios from 1.15:1 to 12:1. Bulletin 5105. **Concentric Shaft** units cataloged up to 225 hp or 4500 rpm. Ratios from 1.5:1 to 25:1. Bulletin 1106.



STEELFLEX COUPLINGS *protect connected machines.*

Hp range: ½ through 72,000 hp at 100 rpm. Exclusive grid-groove design cushions shock loads, accommodates reasonable degrees of shaft misalignment. Basic Type F for 9 out of 10 industrial applications, horizontal or vertical.

Ask for Bulletin 4100.



Basic Type F

AIRFLEX COUPLINGS *Designed for mounting shaft-to-shaft, shaft-to-flywheel, or shaft-to-flange.*

15 sizes covering a range from 5 through 2880 hp at 100 rpm. Ideal for applications which have irregular torque characteristics in driving or driven machines (internal combustion engines, reciprocating compressors, etc.).

Ask for Bulletin 8100.



SINGLE HELICAL and HERRINGBONE GEARS

Exclusive Falk extra-depth, high pressure angle gear teeth provide greater strength and protection against abrasion. AGMA ratings. Hub or ring gears in solid or split designs.

Diameters up to 23'-9" PD.

Face widths up to 6'.

Diametral Pitch: ¾ to 6 DP.

Ask for Engineering Reports 6170 and 6171



Ring Gears

Hub Gears

Special GEAR DRIVES for any application.

Special HIGH SPEED DRIVES... over 50,000 rpm.

Marine PROPULSION DRIVES for turbine and diesel.

FALK, ALL-MOTOR, and STEELFLEX are registered trademarks.

Coal Abroad



RUSSIAN workers concentrate on hand picking in preparation plant.

Russian Mining . . . Fact or Fiction?

Russian paper assails coal mining boasts . . . says production is less per man today than 20 yr ago.

PRAVDA, the Communist party's official newspaper, said recently in an article entitled "Worth Thinking About" that mining conditions in the Donets Basin, known as the Donbas, in southern Russia, producing about one-third of the nation's coal, differ radically from claims of full mechanization and top efficiency made by Donbas officials.

The newspaper disclosed that it took more workers to produce a ton of coal in the basin today than it did 20 yr ago, despite 15 yr of modernization. Half of the mining machines are idle, Pravda said. Aside from those under repair and in reserve, 500 have been abandoned so that operators could be used on manual jobs. The mines' surface activity is generally merchanized while underground the miners try in vain to keep up by using hammers and their bare hands.

The purpose of the expose was not immediately clear. Its concluding plea that party workers help to do things better from now on appeared mild in view of even the partial list of things wrong noted by the paper. Premier Khrushchev, in announcing his 7-yr plan a year ago, described the mechanization of coal mining, especially of the old Donbas mines, as an "urgent task." Although no exact figures are available it is believed Soviet coal production last year totaled 506,500,000 tons, an increase of 2% over 1958. The goal for 1975 is an increase of at least 21% in overall production.

(*Continued on p 54*)

SIMPLEX MINE JACKS

6 WAYS BETTER

★ Ratchet lowering lever type for speed with safety
★ 5-tons capacity (other models to 35 tons)
★ Double-lever sockets permit lifting in close quarters
★ Full capacity on cap *OR GROOVED* toe
★ Safety Speed Trigger
★ Ideal for re-railing, repairs, skidding

No. 84A for Thin Seams 14" high, 7" lift

No. 85A for Medium Seams 17" high, 10" lift

No. 86A for Thick Seams 20" high, 13" lift



SIMPLEX JACKS

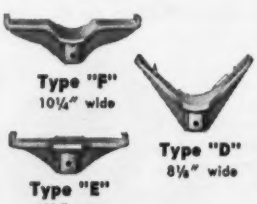
Hi-Speed TIMBER JACK

MODEL NO. 642 LIFTS 6 TONS

Combines safety of screw jack with fast action of crank. Head swivels. Five models with min. ht. from 3'6", max. ht. to 9'6".



3 TYPES OF HEADS



Write for Mines Bulletin for data on the most complete line of Mine Jacks

TEMPLETON, KENLY & COMPANY
WORLD'S LARGEST MFGRS. OF INDUSTRIAL MECHANICAL AND HYDRAULIC JACKS
2501 Gardner Road, Broadview, Illinois

CURTISS-WRIGHT

...A Complete Line of High-Performance Earthmovers



CW-226—26 CU. YDS. STRUCK



CWD-221—35 TON CAPACITY



CW-220—20 CU. YDS. STRUCK



CWD-214—25 TON CAPACITY



CW-215—15 CU. YDS. STRUCK



CWD-321—35 TON CAPACITY



CW-28—8.2 CU. YDS. STRUCK



CWT-30—30 CU. YDS. STRUCK



CW-320—20 CU. YDS. STRUCK



CWT-8—8 CU. YDS. STRUCK

Easy Operation— High Production From C-W Performance Features

Right through the Curtiss-Wright scraper line you find the "extras" that provide top production on any application, any terrain. The constant live power control unit gives you complete control of the bowl at all times . . . Exclusive Roto-Gear steer makes operation easy even on the big 26 cu. yd. CW-226 . . . Positive roll-out ejection gives you fast, smooth operation at the fill area . . . C-W loading characteristics assure top bowl factors on every pass . . . C-W balance provides excellent high-speed control on the haul road. These features and many others make Curtiss-Wright the outstanding performer in any capacity range.

C-W SERVICE A worldwide network of distributors and strategically located parts depots assure Curtiss-Wright users of fast, efficient service on any job location.

A C-W MODEL FOR EVERY APPLICATION

Five self-propelled scrapers with capacities from 8 to 26 cu. yds. struck, up to 36 cu. yds. heaped . . . Three interchangeable rear dumpers with 25 and 35 ton capacities . . . Six tractor-drawn scrapers with capacities from 8 to 30 cu. yds. struck, up to 39 cu. yds. heaped . . . A total of 14 high-performance machines covering the complete range of practical earthmoving applications.

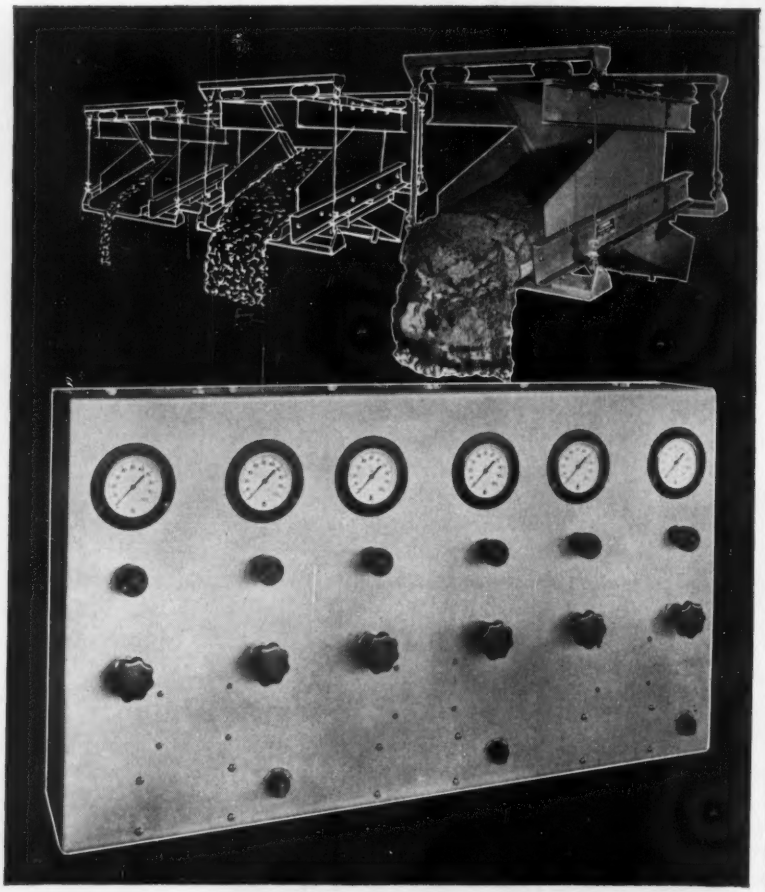
SOUTH BEND DIVISION

CURTISS-WRIGHT

CORPORATION

SOUTH BEND, INDIANA

Distributed in Canada by Canadian Curtiss-Wright Ltd.



From a TORRENT to a DRIBBLE...
AMPLITROL means precise control

With Carrier Amplitrol Feeders you can control discharge rates from ANY distance. Carrier Feeders give you precise manual OR automatic control in response to signals from bin-level indicators, process-alarms, scales, load cells, ball mill or crusher drives.

Speed and Accuracy Combined Three separate Amplitrol Feeders are controlled simultaneously with the control panel shown above. Used in a batch weighing system, the controls produce a fully adjustable high-low feed rate cycle for each feeder. For maximum batching speed with minimum batch variation, Amplitrol feeds the major portion of a batch at torrent rates—the remainder at a dribble. Shutoff at proper weight and recycling is automatic.

For more information, write Carrier Conveyor Division, CHAIN Belt Company, 212 North Jackson St., Louisville 2, Ky.

CARRIER CONVEYOR
NATURAL-FREQUENCY® VIBRATING EQUIPMENT
CHAIN BELT COMPANY

CONVEY • FEED
DEWATER • SCREEN
COOL • DRY
SCALP • COAT
DISTRIBUTE • ELEVATE

Coal Abroad *(Continued)*

Overseas Flashes

BRITAIN—The nationalized coal industry last year incurred a loss of some $56 million, bringing its cumulative deficit since nationalization in 1947 to abou $140 million. The deficit occurred in the second half of the year, following a profit made in the first 6 mo. The loss came chiefly because of a rise in unsold stocks.

RUSSIA—Soviet drilling turbines delivered to Hungary feature new plastic turbine blades which afford lighter unit weight with higher drilling speed at identical blade strength, reported Nepszava, a Hungarian daily, recently. The net result is said to be a great increase in the rotational turbine speed. G. J. Bobrisev, Soviet engineer working in Hungary, says the conventional turbines operate at drilling mud pressure ranging from 995.4 to 1,137.6 psi, achieving rotational speeds ranging from 600 to 800 rpm. This compares to a peak speed of 360 rpm for rotary tables, he said.

GERMANY—The East-German government allotted $1.8 million for drainage works to facilitate what will become Europe's biggest bituminous coal open-pit mining development at Welzow-Sud, East Germany. The mine is one of three similar undertakings located in the Spremberg area which, together, will supply 120,000 tpd of soft coal to the "Black Pump" processing plant at Spremberg, now under construction.

AUSTRIA—Bituminous coal, coke and lignite imports into Austria in 1959 from countries behind the Iron Curtain came to 49.2% of the total. Poland delivered 21.2%, Russia 13.5%, Czechoslovakia 10.1% and East Germany 3.5%. Smaller amounts were purchased from Yugoslavia and Hungary. Austrian coal purchases from the United States decreased in 1959 to 17.8% as compared to 1957's 35.5% of total imports.

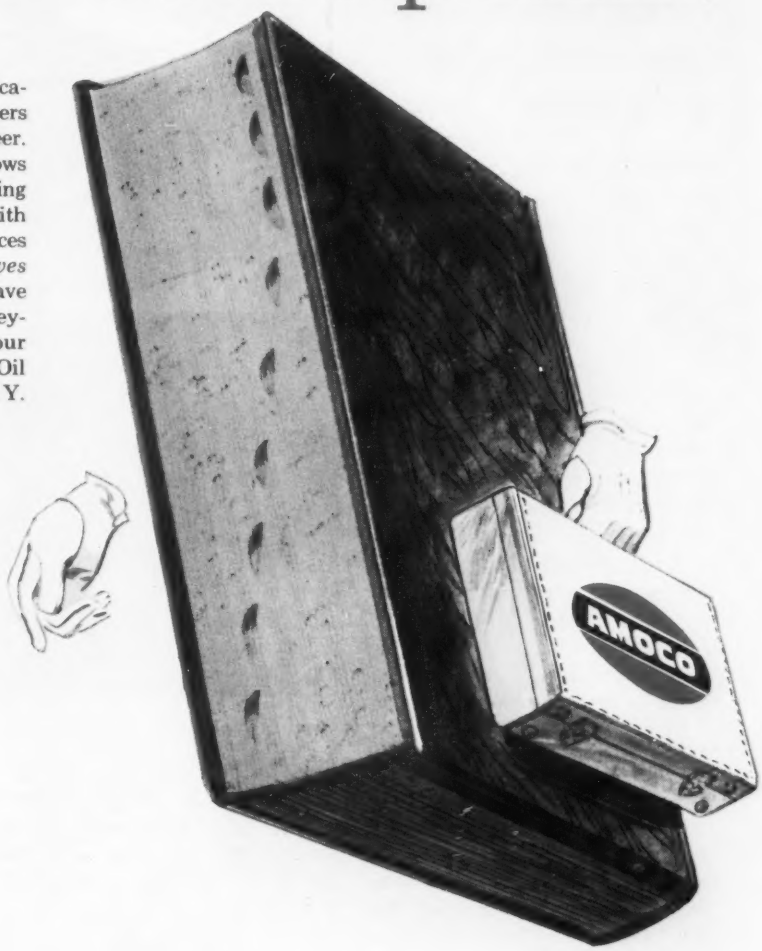
EGYPT—An agreement has been reached between the Egyptian Ministry of Industry and the Soviet Union, whereby, the Soviets will provide mining experts and $4.2 million worth of equipment for geological and geophysical exploration, and mining prospecting to a maximum depth of 1,500 meters, reports Beirut.

CHINA—Red China reported recently that a pair of modern coal shafts with annual capacity of 600,000 tons of coking coal went into operation in Urumchi, the Sinkiang uighur autonomous region, in northwest China. All working processes from cutting and tunnelling to transporting and lifting are said to be mechanized.



You can't stump him!

When you've got a question about lubrication, the man with the *practical* answers is the Amoco mine lubrication engineer. He's a "walking encyclopedia" who knows the theory *and the practice* of lubricating all makes and models of equipment with the right Amoco products. His services cost you nothing. His knowledge *saves* power... repairs... and down time. Have him make a survey and submit money-saving recommendations. Contact your nearest Amoco office, or the American Oil Co., 555 Fifth Avenue, New York 17, N. Y.



AMOCO
LUBRICANTS
for mine machinery





AMOCO

CRACK THE PROBLEM OF HANDLING NEXT WINTER'S FROZEN COAL—NOW!

Pennsylvania's Frozen Coal Cracker is the answer

If frozen coal handling is one of your winter problems—you can solve it with a Pennsylvania Frozen Coal Cracker.

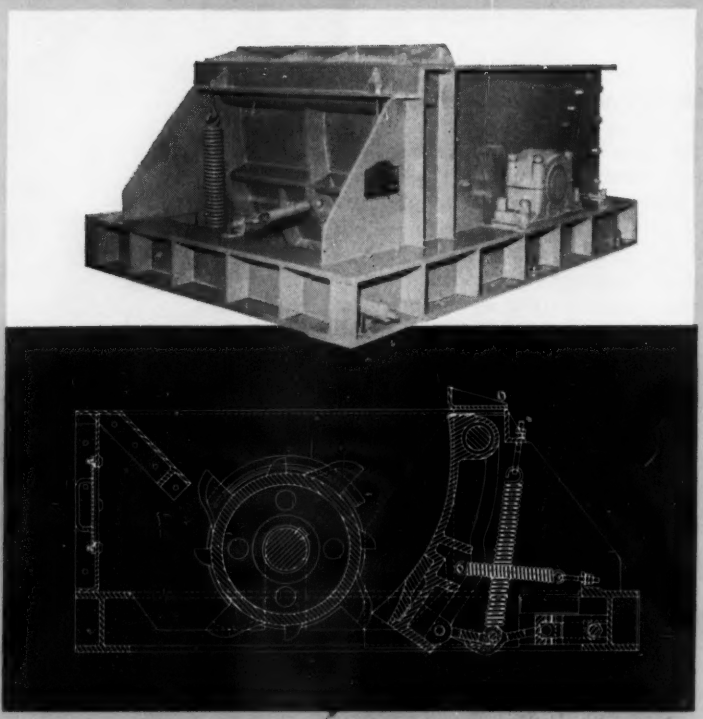
This is the specially-developed cracker with a *wide feed opening*, permitting use of *open-throated* hoppers. Dumped directly into such hoppers (no need for grates) the frozen masses of coal work their way freely to the hopper bottom where they are broken up by blows from the cracker's special teeth.

A uniform product with limited top size and minimum fines is fed conveyors, protecting them from overload, and insuring a continuous flow of coal from unloading point to yards, or yards to plant.

Cracker can be started up with full hopper; operates satisfactorily under choke feed.

Breaker plates are designed so that in warm weather they can be opened up, permitting the coal to pass through without operating the crusher.

Mechanically simple, built-in tramp iron protection. Low headroom required makes the Frozen Coal Cracker ideal to fit into existing hoppers. Drives can be engineered to fit in a minimum of space. Capacities up to 1200 tons per hour. Available in single or twin units.



ACT NOW

Don't be plagued by hopper jams, overloaded conveyors, slowdowns and high labor costs. Act now. Write for new Bulletin 2013.

PENNSYLVANIA CRUSHER DIVISION
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

★ ★ ★

Over 50 years' concentrated experience in all types of material reduction makes Pennsylvania your best source of crushers and engineering advice and service. Call on Pennsylvania with your next crushing problem. Representatives from coast-to-coast.

PENNSYLVANIA CRUSHERS
BATH-BUILT



DAVID D. EYER (left), Hamburg, Pa., was named the top mining engineering student at Lehigh University this year. He received the gold watch award of the Old Timers Club from Edward Fox (right), management representative for the Bituminous Coal Operators Bargaining Committee, who represented the donors. Dr. Robert T. Gallagher (center), is the head of the mining engineering curriculum at Lehigh.

Canadian Coal

Canada's coal production in March climbed steeply to 1,021,000 tons from 704,061 in the same 1959 month.

This rise boosted the January-March total 9.4% to 3,176,221 tons from 2,904,383 in last year's first quarter. Landed imports were smaller in the month at 199,751 tons versus 290,966 and in the 3-mo period at 567,700 tons versus 958,100.

Greater coal production in January-March in Nova Scotia and British Columbia and the Yukon more than offset smaller output in the remaining producing areas. First quarter totals were: Nova Scotia, 1,386,304 against 963,744 a year ago; New Brunswick, 258,887 against 278,736 last year; Saskatchewan, 681,828 against 714,945 a year ago; Alberta, 631,438 against 752,365 last year; and British Columbia and the Yukon, 218,764 against 194,563 last year.

Denies Motion

The Federal Power Commission has denied a motion by NCA, Fuels Research Council, and other coal, railroad and labor intervenors to reopen the case which allowed Midwestern Gas Transmission Co. to import natural gas from Canada to the Mid-West area.

STOP



CABLE FAILURE

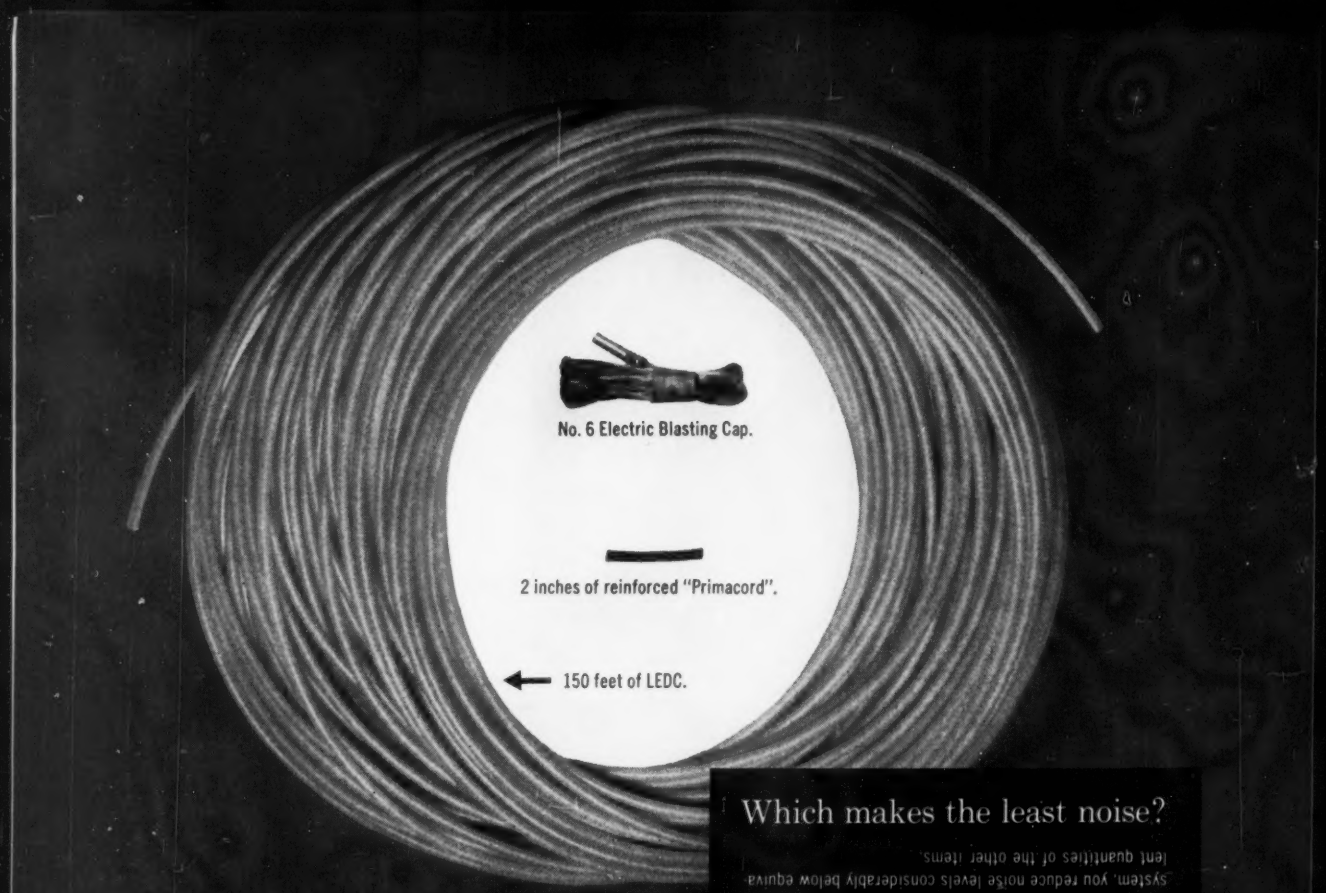
Put the "hex" on off-track mining machine down time .... with the new Collyer Twin Type G Portable Power Cable with hex-shaped parallel conductors. This construction *locks conductor assemblies in place,* prevents twisting and shifting, assures longer flexing life . . . AND LONGER CABLE LIFE!

Insulated with heat-resistant natural rubber . . . sheathed with Collyer's tougher, more durable Neoprene sheath compound to give greater resistance to abrasion, tearing, crushing. Compression cutting is "hexed", too, by natural rubber insulation!

Write today for complete information on how this new cable can put a stop to resplicing down-time and replacement overhead.

Collyer

COLLYER INSULATED WIRE CO.
257 ROOSEVELT AVENUE
PAWTUCKET, RHODE ISLAND



Shhhh!

New Du Pont delay blasting system* hushes the noise of quarry, open pit and strip mine blasting

If you have been burying your "Primacord" trunk lines, or have reluctantly switched to electric blasting caps in order to reduce the noise level of your blasting, here's good news.

Reduces noise The new Du Pont Low Noise Level Trunk Line Delay Blasting System* uses LEDC (Low Energy Detonating Cord) developed by the Ensign-Bickford Company in a cooperative program with Du Pont. It muffles the noise without the nuisance and expense of burying the cord. 150 feet of LEDC makes no more noise than one electric blasting cap!—or 2 inches of ordinary "Primacord"!

2 grains per foot This low noise level trunk line system contains only 2 grains of explosives per foot, as contrasted to 50 grains per foot in the regular "Primacord." It is this tiny load that keeps the noise level down. Our customers report noise and vibration complaints from neighboring residents were actually eliminated, when LEDC trunk lines were recently introduced.

Other features This system uses trunk line delay connectors, available in intervals of 10, 15 and 25 milliseconds. You can select the interval best suited to your particular blasting problem. The low noise level trunk line delay blasting system provides an unlimited number of periods at intervals of 10, 15 or 25 milliseconds. And at no time is it ever necessary to place a blasting cap in the borehole.

Available now Your Du Pont distributor or representative can help you reduce your noise problem with new LEDC at once, or answer your questions about it. Call him. Or write Du Pont, Explosives Department, 6440 Nemours Bldg., Wilmington 98, Del.

**Patent applied for*

DU PONT EXPLOSIVES

REG. U.S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*



Where heavyweights move job records prove...

FIRESTONE TOUGHNESS PAYS OFF BIG!

Extra toughness: you get it in the cord, in the rubber . . . in every inch of Firestone off-the-highway tires. And it pays off big! Helps keep equipment on the job; helps keep jobs on schedule. Behind Firestone toughness are such exclusives as (1) Firestone Rubber-X, longest-wearing rubber ever used in Firestone tires and (2) Firestone Shock-Fortified nylon cord for top protection against impact damage. Through Firestone's Giant Tire Service, an expert will match tires to your job, and handle all tire maintenance. Just contact your Firestone Dealer or Store. Or write: Manager, Off-The-Highway Tires, The Firestone Tire & Rubber Co., Akron, Ohio.

ALWAYS SPECIFY FIRESTONE TIRES WHEN ORDERING NEW EQUIPMENT



Super Rock Grip Wide Base* Super Rock Grip Deep Tread*

TUBELESS OR TUBED

Firestone

BETTER RUBBER FROM START TO FINISH

Copyright 1960, The Firestone Tire & Rubber Co.
*Firestone T.M.



Metallurgical Memo from General Electric

Here's where G-E Carboloy® machine bits pay off!



...and where the difference in carbide bits shows up!

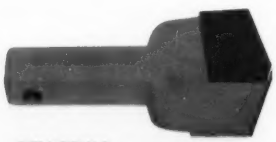
Bit illustrated: CC-9

The payoff shows up in the pile. Claims of faster, freer cutting machine bits . . . uniform carbide quality . . . reliability . . . longer bit life are best proved by tonnage output per shift. That's where you see the difference in Carboloy bits.

No longer do production-conscious operators gamble with "look alike" machine bits. They protect their machine investment with G-E Carboloy bits. Your Authorized Carboloy Mining Tool Distributor (listed on adjoining page) stocks the silver-colored tools ready for immediate delivery. Remember, there's a Carboloy engineer in your area for prompt assistance. Phone or write to *Metallurgical Products Department of General Electric Company, 11145 E. 8 Mile Rd., Detroit 32, Michigan.*



APT STYLE
2-Prong Roof Bit—Cuts straight, clean, on-gage holes fast in medium formations. Longer tool life.



PTV STYLE
Roof Bit—Solid insert. Tipped with wear-resistant carbide for maximum hole footage between regrinds.

CARBOLOY
CEMENTED CARBIDES
METALLURGICAL PRODUCTS DEPARTMENT
GENERAL ELECTRIC

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRITE® • VACUUM-MELTED ALLOYS

Complete service through factory and distributor assistance

AUTHORIZED CARBOLOY MINING TOOL DISTRIBUTORS

ALABAMA
Birmingham 2—Shook & Fletcher Supply Company

COLORADO
Denver—The Mine & Smelter Supply Company

ILLINOIS
Mt. Vernon—Pickard Industries, Inc., Central Mine Supply Division

INDIANA
Terre Haute—The Mine Supply Company, Inc.

KENTUCKY
Harlan—Kentucky Mine Supply Co., Inc.
Lothair—Speck Cornett Distributor, Inc.
Madisonville—Pickard Industries, Inc., Central Mine Supply Div.
Paintsville—Farmers Supply Co.
Pikeville—Big Sandy Electric & Supply Co.

OHIO
Cambridge—Cambridge Machine & Supply Co., Inc.

OREGON
Portland—J. E. Haseltine & Company

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Salt Lake City—The Mine & Smelter Supply Co.

VIRGINIA
Andover—Central Supply Co., of Va., Inc.
McClure—Erwin Supply Company

WEST VIRGINIA
Bluefield—Bluefield Supply Co.
Bluefield—Fairmont Supply Company
Bluefield—Rish Equipment Company
Charleston—Rish Equipment Company
Clarksburg—Rish Equipment Company
Fairmont—Fairmont Supply Company
Montgomery—Marathon Coal Bit Company, Inc.
Shinnston—Erwin Supply Company

News Roundup *(Continued)*

FPC ruled that issuance of a 20-yr export permit by Canada was not inconsistent with the FPC certificate, which was predicated on a 25-yr supply. The commission also rejected coal's objection that Midwestern's financing plan was accepted after the hearings closed, so that intervenors were unable to question the proposal and cross-examine financial witnesses.

The commission ruled it has power to insert conditions in a certificate concerning such things as financing plans. Commissioner Arthur Kline dissented, saying that the financing plan was such a change from matters discussed in the hearing that intervenors should have been heard on it.

Mines, Companies

An error in compilation by the staff of Keystone Coal Buyers Manual, a Coal Age affiliate, resulted in the omission of the Ireland mine of the Hanna Coal Co., Div. of Consolidation Coal Co., from the list of the 50 biggest bituminous mines in 1959. With an output of 1,719,452 tons in that year, Ireland, at Moundsville, W. Va., ranked 17th in the 1959 list. The staffs of both *Keystone* and *Coal Age* sincerely regret this inadvertent omission of an outstanding property from the list of the 50 biggest.

Glen Alden Coal Div., of Glen Alden Corp., diversified industrial company, and Hudson Coal Co., reported they have been studying possible benefits of managing their respective anthracite properties jointly. The firms noted they are seeking economies to meet growing problems.

Preparation Facilities

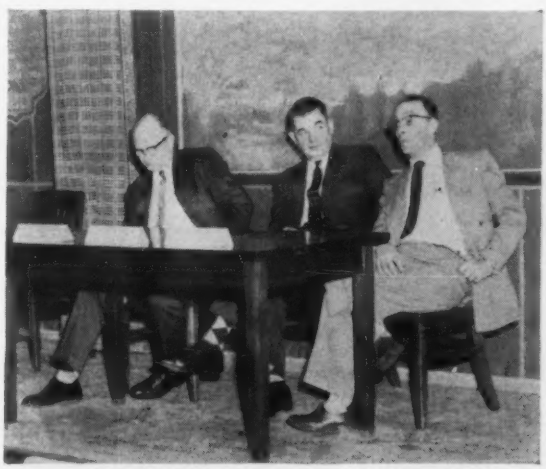
Pocahontas Fuel Co., Itmann colliery, Itmann, W. Va.—Contract closed with The Deister Concentrator Co., Inc., for three Concenco No. 66 Diagonal Deck washing tables.

Nassau Coal Co., Black Wolf, W. Va.—Contract closed with The Deister Concentrator Co., Inc., for one Model HCRD Concenco No. 77 Diagonal Deck washing table to handle ⅜x0 coal.

The Carbon Fuel Co., Mine No. 6, Winifrede, W. Va.—Contract closed with Kanawha Mfg. Co. for crushing, storage and conveying facilities to handle 500 tph of ROM coal.

Nassau Coal Co., Blackwolf, W. Va.—Contract closed with Kanawha Mfg. Co. for a Deister table plant with 15-tph capacity for cleaning air-table refuse, including one No. 77 Double Deck table.

Experts Look Ahead at Mining



FUTURE of the mining industry and opportunities for mineral engineers is subject of panel discussion sponsored recently by The Mining Society, Pennsylvania State University's AIME student chapter. Panelists, representing segments of mining industry, included (left to right): J. F. Core, vice president, coal operations, United States Steel Corp., representing the coal industry; J. C. Cosgrove, district manager, Goodman Mfg. Co., representing sales and the mining equipment manufacturers; and D. W. Mitchell, chief of the Mine Experiment Sect., Bureau of Mines, representing government service. Conclusions were that the mining industry will require an increasing number of engineers in the future because rapid mechanization and automation will create additional problems in roof control, ventilation, power distribution, maintenance and preparation.



A COAL FIELD FAVORITE

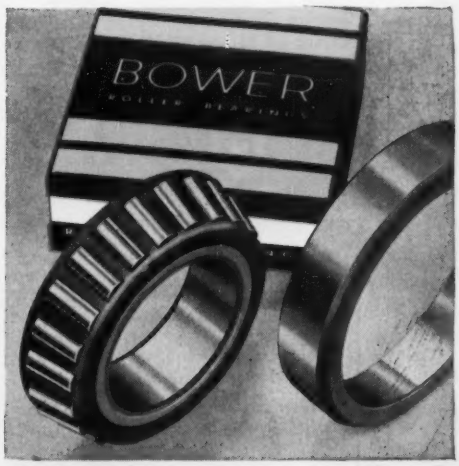
MARION WALKING DRAGLINES

For 18 years, Marion Walking Draglines have been providing practical solutions for coal stripping problems. They do it in a very simple way . . . by giving the operator the plus features he needs to make himself and the machine look good on the job. These include the reach necessary to stack overburden high and far away; the capacity to move big yardage consistently; the ability to work and travel on soft footing without danger of bogging down. Marion Walkers are available in sizes from 5 to 40 cubic yards and carrying boom lengths to 280 feet. Pictured is a Marion 7400 carrying a 13-yard bucket on 175 feet of boom in a Pennsylvania stripping operation. Write for Bulletins 426, 427, 428 and 429 describing the entire line of diesel-electric and full-electric powered Marion Walkers. *The Marion Power Shovel Company, Marion, Ohio . . . A Division of Universal Marion Corporation.*

Better products, *faster*, from your Bearing Specialist:



Where output counts, you'll find Bower Spher-O-Honed roller bearings on the job



Be sure your replacements call for Bower . . . the bearings with the high availability record

Among mine operators, Bower tapered and straight roller bearings continue to prove their superiority under all types of loads.

The design of Spher-O-Honed tapered roller bearings insures better lubrication, smoother surface for less friction under load and longer life. Another important reason for making all replacements from the Bower line is *availability second to none* in all sizes you need. Contact your bearing specialist whenever replacements are due. He's always nearby to help with the right sizes and types for the job.

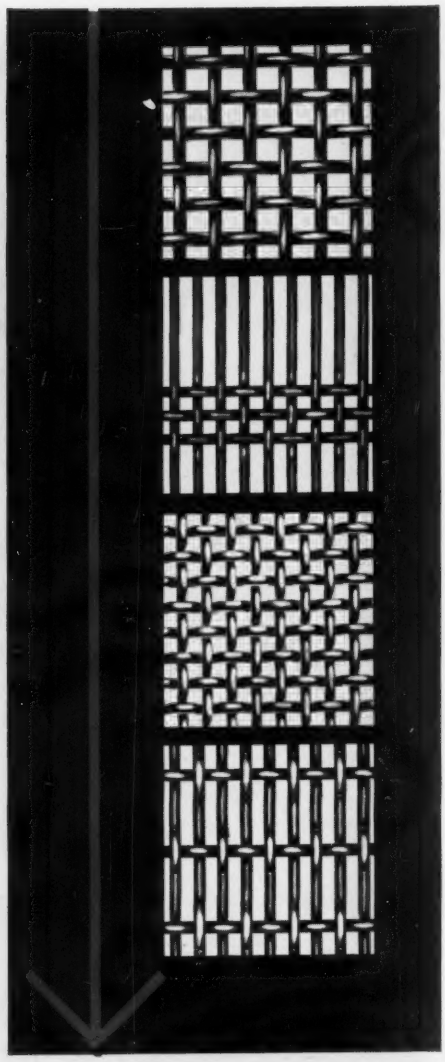
BOWER ROLLER BEARINGS

FEDERAL-MOGUL SERVICE

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 13, MICHIGAN

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Lower Cost Screening



Whatever the job—whether the problem is corrosion, abrasion, vibration, heat, pressure—actual on-the-job tests will prove what thousands of customers have discovered: L-S Wire Cloth & Screen last longer, retain original dimension stability better, produce higher quality products of consistent uniformity. Order L-S Cloth & Screen by name—get the industry's finest. Prices are sharply competitive. *Write for Condensed Screen Reference Catalog.*

LUDLOW-SAYLOR

SPACE SCREENS

Woven from any steel or any other metal that can be drawn into wire

IMMEDIATE SHIPMENT-Most weaves & sizes

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PITTSBURGH Union Trust Bldg.
HOUSTON 5638 Harvey Wilson Dr.

FOUNDED 1856

New Books

Mine Valuation

Mine Examination Reports and Valuation, by James H. Pierce, chairman of the board, Pierce Management Corp., and Thomas F. Kennedy, consulting engineer. The wide and varied experience of the authors is complete surety of the accuracy and comprehensiveness of this down-to-earth text. Part I, dealing with examination of coal mines, both U. S. and foreign, covers everything from the qualifications of the engineer through the scope and form of the examination and coal sampling to water studies, estimation of production costs and economic considerations in examinations.

In Part II—the valuation of coal properties—the basic principles and formulas are supplemented by a detailed discussion of development questions and, getting to the heart of things, valuation methods to be used with either developed or undeveloped coal property, winding up with royalties, how the valuation report should be organized, and practical considerations in valuing anthracite coal lands, particularly, for tax purposes.

Buying, selling, leasing or getting the best break possible in local taxes, this book brings you the latest and best in principles and practice. 255 pp. 5¾x8½ in; cloth. $10, with 10-day examination privilege. Pierce Management Corp., P.P.&L. Bldg., Scranton 3, Pa.

Blasting

Use of High-Speed Camera in Blasting Studies, by Byron E. Blair, Bureau of Mines, Publications-Distribution Sect., 4800 Forbes Ave., Pittsburgh 13. Special film using high-speed photography enables engineers to get a clearer understanding of what happens when rock is shattered by explosives.

Meetings

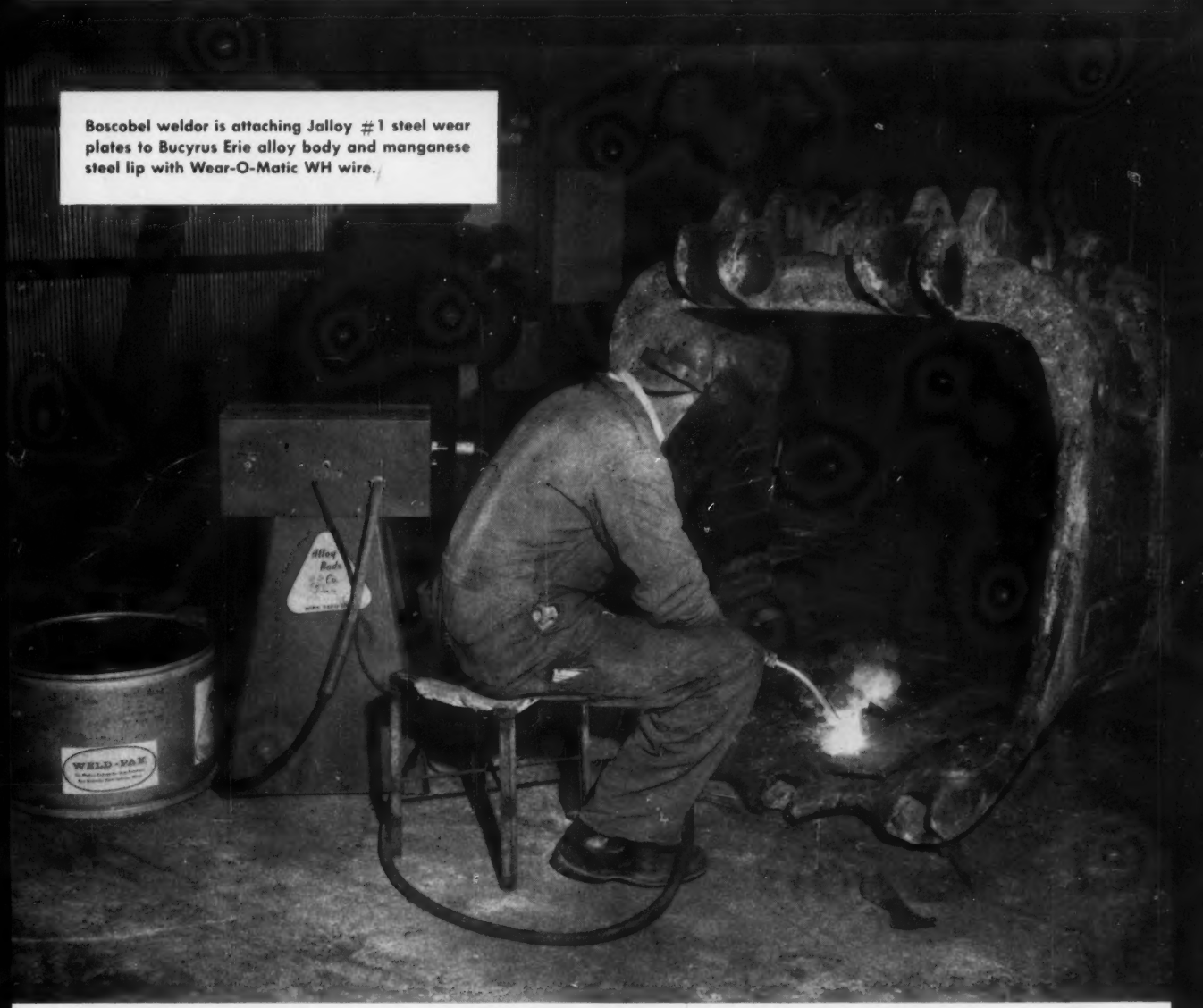
Bluefield Coal Show, Sept. 21-23, Bluefield, W. Va.

National Safety Congress, 48th annual meeting, Oct. 17-21 — Conrad Hilton Hotel, Chicago.

Biannual Symposium on Drilling & Blasting, Oct. 17-19 — Colorado School of Mines, Golden, Colo.

Twenty-third annual ASME-AIME Joint Solid Fuels Conference, Oct. 24-25—Daniel Boone Hotel, Charleston, W. Va.

Coal Mining Institute of America, 7th annual meeting, Dec. 15-16—Sheraton Hotel, Pittsburgh, Pa.



Boscobel weldor is attaching Jalloy #1 steel wear plates to Bucyrus Erie alloy body and manganese steel lip with Wear-O-Matic WH wire.

35% Savings on bucket maintenance with NEW Wear-O-Matic WH welding wires

"Wear-O-Matic WH is the most versatile welding wire for bucket maintenance because it provides high strength welds in any of the popular alloy steels and has excellent resistance to impact when used for build-up work. Savings in time and labor through the semi-automatic open arc application of this wire have resulted in less bucket down time and lower costs."

L. ARDEN HENLEY, SUPT.
BOSCOBEL GRANITE CORP., MANAKIN, VA.

WHAT about bucket maintenance in your shops? Costs too high due to too many manual welding applications? The important benefit gained by Boscobel Granite was the elimination of manual welding with stainless steel electrodes to obtain the necessary high strength attachment welds for their rugged rock handling chores. These benefits can be yours whether you are welding manganese to manganese, manganese to carbon steel or either of these to any of the abrasion or impact resistance alloy steels. Then, without changing wires, your weldor can apply build-up deposits to lesser worn areas such as latch pins, keepers and lips . . . a deposit that will work harden to outwear manganese steel. To put more service life in the business end of your shovels and drag lines, investigate today the semi-automatic open arc application of Wear-O-Matic WH wires. You'll lower your maintenance costs . . . decrease down time and increase working life. For complete details, request Bulletin AR-21. Alloy Rods Company, P. O. Box 1828, York 14, Pa.

ALLOY RODS COMPANY

YORK, PENNSYLVANIA

SALES OFFICES AND WAREHOUSES • NEWARK, PITTSBURGH, PHILADELPHIA, BOSTON, CHICAGO, SAN FRANCISCO, EL SEGUNDO, CALIFORNIA — DISTRIBUTORS IN ALL OTHER PRINCIPAL CITIES

TWENTY YEARS OF LEADERSHIP IN THE DEVELOPMENT OF QUALITY ALLOY ARC WELDING ELECTRODES

HAULS OF

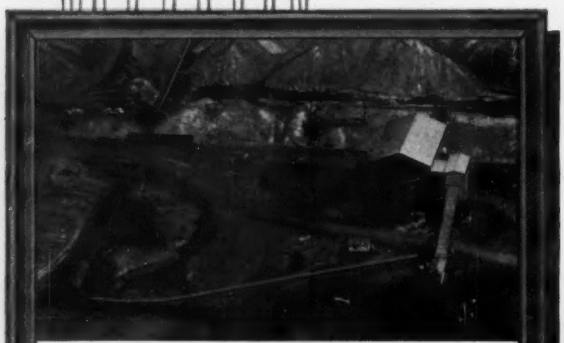
HERE ARE on-the-job stories of five United States Rubber Conveyor Belts, taken from "U.S." belt records in the coal mining industry.

These belts are just some of the "U.S." standouts which demonstrate, year after year, why "U.S." is the world's largest producer of conveyor belts.

For steady, day-in and day-out dependability in conveyor belting, it always pays you to secure the advantages of "U.S." Engineering. "U.S." Engineers work directly with "U.S." Distributors or original equipment manufacturers to assure their obtaining the right belt recommendations for each type of conveying.

The most comprehensive belting engineering information in the industry is available through your "U.S." Distributor. It will pay you to check with him.

Visit famous U.S. Tipple Inn, Penn-Sheraton Hotel, Pitts., Pa., May 8-10.



U. S. CONVEYOR BELTS

"A revolution in strip mining," says superintendent, "U.S. Conveyor Belt helps us save $1500 per week."

The Will Scarlet mine near Stonefort, Ill., has an outstandingly successful use of the first overland belt conveyor in a strip mine. The conveyor belt system, using a U. S. Giant® Belt, reduces the number of trucks, eliminates extra roads and high maintenance costs. The belt makes possible economical stockpiling for continuous operation: miners can continue working without a tipple operation—or the tipple can produce without a mining operation. The system can be moved to any location on the 3,000-acre tract. As the pit progresses overland, more lengths are simply added to the belt. "Maintenance costs are very low. Our savings are $1500 per week. We intend to install additional 'U. S.' Belting soon." *Another Three-Way Engineering Triumph.*



"After 20 years, 'U.S.' still gets the replacements," says plant foreman

Mr. James Campbell of Guyan-Eagle Coal Co., Kelly, West Va., knows why Guyan-Eagle has been using (and replacing with) "U. S." belts in their 5 mines. In the words of the company's own officials, "U. S." Belts are:

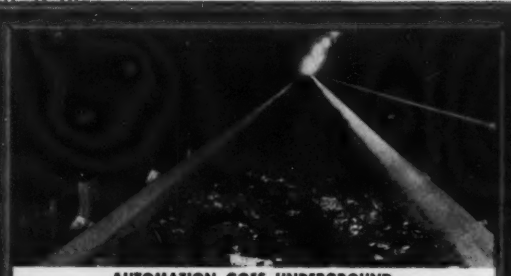
"The most dependable in our experience."
"Resistant to abrasive action of rock."
"Strong, durable—maintenance is minimum."

FAME



40,000,000 tons of washed coal

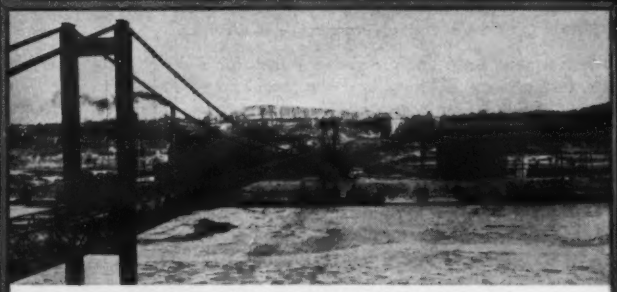
This is the minimum tonnage expected to be hauled in an estimated 12-year life by the main "U. S." belt. Installed in U. S. Steel's Robena Coal Mine, Uniontown, Pa. Robena is three mines, serviced by the same preparation plant. It is one of the largest coal-producing units in the nation. A single U. S. Rubber slope belt (installed 1953) conveys all the washed coal, amounting to over 20,000 tons a day. An earlier "U. S." Belt (installed in 1951) conveys coal to the blending bins.



AUTOMATION GOES UNDERGROUND

"U. S." Belts help make foolproof the push-button conveyor system in the Dana Slope Mine of Amherst Coal Co., (Rensford, West Va.).

Limited storage capacity, both inside the mine and on the surface, makes it mandatory that this slope conveyor operate without stoppage. So Amherst, knowing the "U. S." reputation for dependability and long life, selected a 42" U. S. Giant 6-ply YN belt. Operating since 1952, it has given completely trouble-free service.



Coal crosses the river on a belt 3870 feet long

Jones & Laughlin preparation plant at La Belle, Pa., is one of the world's largest. Here outputs from Vesta and Shannopin mines are combined.

Coal from the Vesta is carried across the river on a 3870-foot U. S. Rubber Conveyor Belt supported by the world's longest belt conveyor suspension bridge. This belt (actually all the belts in the system are "U. S.") has been operating since 1948 without a breakdown. In these eleven years it has carried a total of 44 million tons so far.

US RUBBER

Mechanical Goods Division

United States Rubber

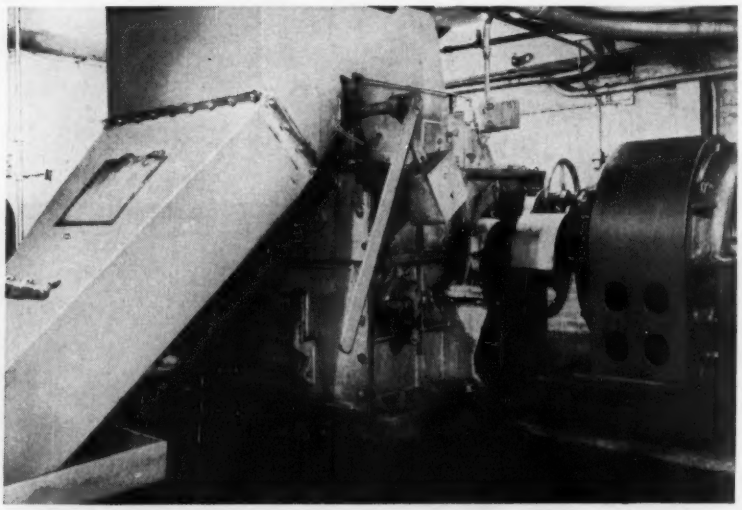
WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.



CRUSHING FACTS

from *American* PULVERIZER CO.



USER REPORT

"7,000,000 TONS OF COAL reduced to 3/4" by this crusher, and it is still going strong"

After 23 years of operation, this American AC Rolling Ring Coal Crusher is still giving excellent service.

Replacement parts, plus standby parts, for reducing 7,000,000 tons of coal have cost less than 1/5 of a cent per ton. **Quality is proven only by performance.**

There are solid engineering reasons for this performance. The crushing elements, composed of American-originated rolling shredder rings, split coal instead of crushing it. This means less wear on screens and liners, less attrition in the crushing chamber. The rings are manganese steel and are reversible to give double wear. Liners are easily replaced.

The entire rotor assembly and bearings are so carefully machined, aligned and balanced that a nickel will stand on edge when the crusher is operating!

You can depend on performance like this when you use an American Coal Crusher. Our engineers will advise you on the correct model for your reduction problem.

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

1119 MACKLIND AVE. ST. LOUIS 10, MISSOURI

6005

People in Coal *(Continued)*

as first vice president. Elected to the office of first vice president was **H. C. Livingston,** president, Truax Traer Coal Co., Chicago. Other officers of the institute are: chairman of the board—**Stuart Colnon,** president, Bell & Zoller Coal Co.; second vice president—**Mark E. Eastin Jr.,** president, West Kentucky Coal Co.; third vice president—**W. S. Webster,** president, Snow Hill Coal Corp.; treasurer—**J. M. Morris,** president, The United Electric Coal Cos.; secretary and manager—**J. E. Tobey Jr.,** Chicago; and assistant treasurer, **Martha A. Terleke,** Chicago.

Earl J. Evans, vice president and controller, Spring Canyon Coal Co. and Royal Coal Co., Salt Lake City, Utah, has been elected president of the Utah-Wyoming Coal Operators Association. He succeeds **Glen E. Sorensen,** president of the Kemmerer Coal Co. and the Gunn-Quealy Coal Co., Frontier, Wyo. **H. J. Schultz,** manager, Western Coal Mining Co., Carbon County, Utah, was elected vice president. **Grant A. Foulger,** treasurer and assistant general manager, Lion Coal Co., Ogden, Utah, was elected a new member of the association's board of directors.

Edward S. O'Connor, 77, president of Book Cliffs Coal Co., Carbon County, Utah, passed away recently. Mr. O'Connor, born at St. Paul, Minn., came to Utah in 1928 to work in the Cedar City iron mines of Columbia Steel Co., now U. S. Steel Corp.'s Columbia-Geneva Div. Mr. O'Connor was named superintendent of Carbon County coal mines of U. S. Steel, and retired in 1949. Since that date, he had served as president of Book Cliffs Coal.

Bituminous Output

YEAR TO DATE	PRODUCTION
June 18, 1960	203,325,000
June 20, 1959	202,967,000

1960 output 0.2% ahead of 1959.

WEEK ENDING	PRODUCTION
June 18, 1960	8,895,000
June 20, 1959	9,359,000

Anthracite Output

YEAR TO DATE	PRODUCTION
June 18, 1960	8,325,000
June 20, 1959	9,863,000

1960 output 15.6% behind 1959.

WEEK ENDING	PRODUCTION
June 18, 1960	375,000
June 20, 1959	423,000



Now "trade" dead weight for payload..and haul 40% faster!

Heap-load the big-target Payhauler body in minimum time. Strong rock-ribbed corrugations absorb shock—resist wear and distortion. Choose the "95" with power-shift Torque-Converter, or 9-speed air-shift transmission.



New strength-multiplying corrugated body design results in payload-gaining weight reduction of both International Payhauler models. New "95" capacity is increased to 27 tons—and the new "65" becomes the only 19-tonner on the market!

Look at those exclusive, rock-ribbed body corrugations! International applies this strength-multiplying principle to reduce Payhauler® body weight by an amazing 30%! You "trade" 2½ tons of power-wasting dead weight for 3 bonus tons of payload capacity in the new 95 Payhauler!

New high-torque, high-output diesel power highballs 27-ton payloads up to 40% faster than the former "95" could haul only 24 tons! The new 375 hp DT-817 International diesel engine gives the new 95 Payhauler the wallop of 40 extra turbocharged "horses."

Prove to yourself that top load-carrying capacity plus top power-to-weight ratio give 95 Payhaulers tremendous profit-earning advantages. Add up other big Payhauler exclusives: fast reverse, up to 7.1 mph. for spotting speed; big-target bodies for loading zip; 11-second inverted-hoist dumping; load speeding safety of torqmatic braking and positive power-steering! Let your International Construction Equipment Distributor demonstrate!

International® Construction Equipment

International Harvester Co., 180 N. Michigan Ave., Chicago 1

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors ... Self-Propelled Scrapers and Bottom-Dump Wagons ... Crawler and Rubber-Tired Loaders ... Off-Highway Haulers ... Diesel and Carbureted Engines ... Motor Trucks ... Farm Tractors and Equipment.

"Planet-powered '25"



"Our International TD-25's turbocharged engine doesn't seem to lug down under load," states Charles Skelton, superintendent for Mulzer Brothers, Tell City, Indiana. "This power, combined with planetary steering and Hi-Lo power shifting gets full loads fast and speeds-up load delivery stripping overburden."

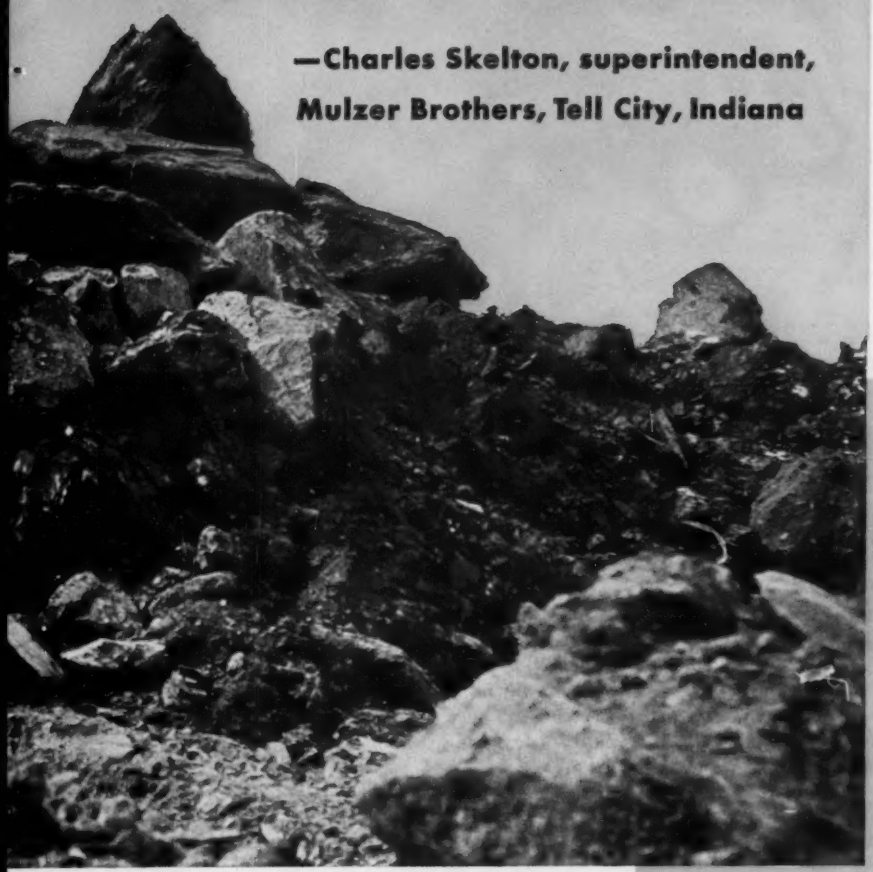
That's another way of saying that the "25," working three shifts daily on this coal-stripping operation, gives operating efficiency a big boost! They're stripping 30-foot overburden to get at a 42-inch coal seam: one-third earth; two-thirds shale, slate, and rock. The "25" takes off the top third—pushing full blade loads an average of 100 feet. A 6-yd. dragline removes the rest.

How a "25" outblades other rigs up to 50%—You 'doze straight ahead with heavy offset loads—you make full-load, full-power turns—where giant clutch-steered rigs slip, slue, and spill the load. Exclusive TD-25 "live track" Planet Power-steering eliminates load-limiting "dead-track drag."

With exclusive Hi-Lo, on-the-go power-shifting, the "25" gives you instant, all-the-way matching of power to condition. You roll up big loads in a hurry—and

gets full loads fast . speeds up delivery, stripping overburden"

—Charles Skelton, superintendent, Mulzer Brothers, Tell City, Indiana



Stripping overburden three shifts daily, Mulzer Brothers' TD-25 blades full loads, an average of 100 ft. Planet Power-steering and Hi-Lo power-shifting keep full loads on the move full time. On benching or highwalling, simply operate the bank-side track in high speed range, while keeping the outside track in low range—for full-bite, full-blade performance.



Here's your 76-page cost and production estimating book— newest, most authentic and complete guide for estimating material-moving costs—and for selecting equipment combinations for top profits, anywhere! See your International Construction Equipment Distributor!

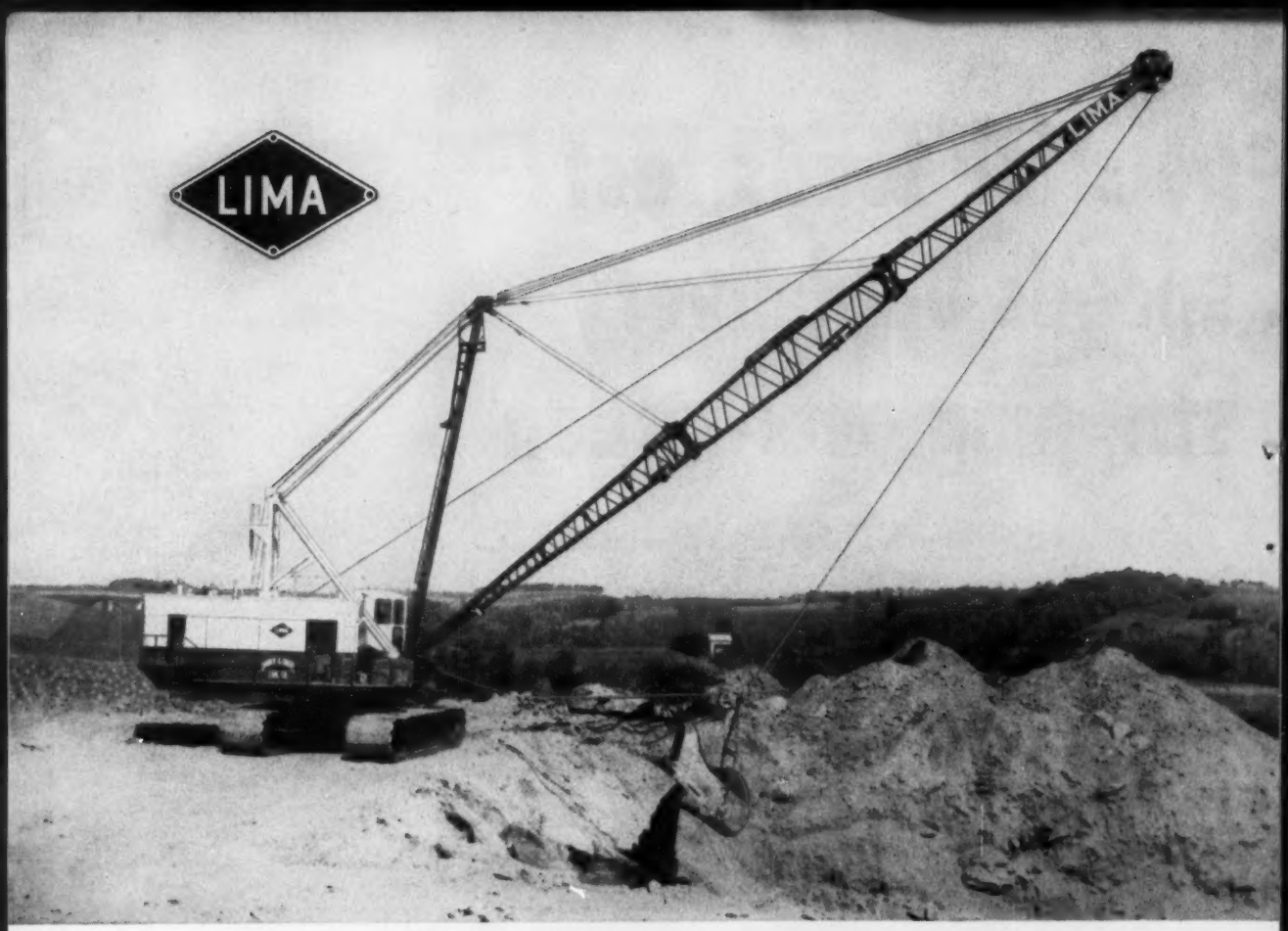
keep 'em rolling fast. And with exclusive International DT-817 Diesel engine wallop, the "25" bulls along, 230 turbocharged hp strong—without "slow-motion" lug-downs, even at high altitudes!

Press the direct-start button—power-shift and power-steer the planet-powered TD-25 with full-king-size loads—around curves, upgrade, anywhere. Prove what it means to command full-time, full-load ability to outwork and outearn king-sized clutch-steered crawlers—up to 50%! See your International Construction Equipment Distributor for a demonstration!

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Giant Lima 2400 dragline equipped with 7-yd. bucket moves an estimated 3000 yd. in 9-hr. shift.

7-yd. LIMA dragline works 19 hours daily; maintenance less than $50 in 2 years!

"The Lima 2400 dragline is the best equipment buy we've ever made. It recovers about 500 tons of coal a day, working a 10- and a 9-hour shift. Yet maintenance costs in 2 years have amounted to less than $50."

Outwear, outlast, outstrip

"I checked before I bought the Lima—for my money, Limas are bigger, heavier and better built than comparable rigs of other makes. From wide, heavy duty brake and clutch bands to shock-reducing torque converter, the 2400 is designed to outwear, outlast and outstrip other machines on the market.

"I was impressed by the field service that the factory engineers provided in adjusting the new machine for me. They also saw to it that my operators were thoroughly familiar with the 2400. Both parts and service from factory and distributor are excellent. We also have a Lima Type 34 Paymaster. Both Limas have proven to be high performance, low maintenance machines." *From a report by the Harold A. Siegel Coal Company, Clarion, Pa.*

Make more money

Chances are a Lima could help you make more money by stepping up production and reducing operating costs because of its low maintenance requirements. Get the facts about Limas before you buy your next machine. There's a type and size exactly right for your needs. Variable capacity draglines; shovels to 8 yd.; crawler cranes to 140 tons, 80 tons on rubber. For complete information, see your nearby distributor or write to Construction Equipment Division, Baldwin-Lima-Hamilton Corporation, Lima, Ohio.

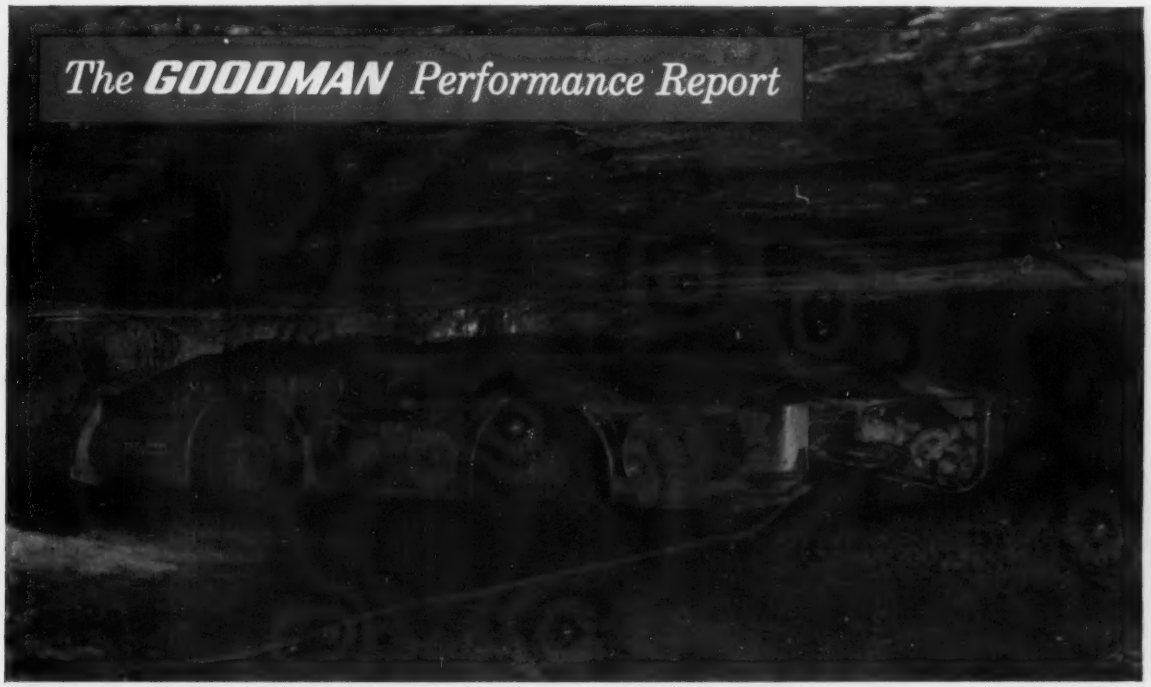
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How to get trouble-free transfer of payloads

The Answer: Goodman shuttle cars—in both low and high coal . . . behind loaders or continuous miners.

All Goodman shuttle cars, from the low (26″ basic) to high (54″ basic), are known for structural strength, capacity, ease of handling, and mine service motors designed by Goodman.

Structural Strength: The frame, a welded, one-piece unit reinforced with heavy cross-members, affords protection for the operator and for all mechanisms. The conveyor pan is steel, selected for strength and resistance to abrasion and corrosion. Wheel spindles are extra strong, and with drive and steering knuckles are mounted to provide a 3-point wheel suspension that levels off uneven bottom, maintains even weight distribution.

Capacity: There is always capacity for surge loads. The low type 870-20, with its 57″ wide conveyor, consistently hauls 3½ to 4 tons. Higher models (some with 54″ conveyors) often carry in excess of 10 tons.

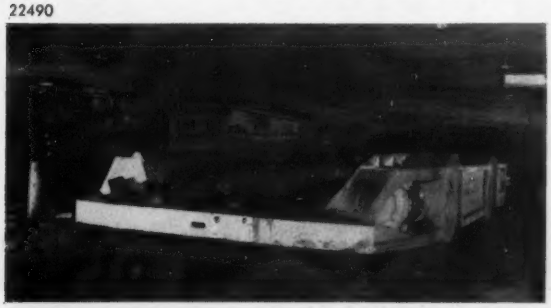
Ease of Handling has always been a Goodman feature . . . with such advantages as 4-wheel power steering . . . 4-wheel disc-type brakes with independent hydraulic system . . . 4-wheel drive . . . smooth low and high speed control through a 2-position foot switch.

Each of the Three Motors on a Goodman shuttle car is *designed* and *built* by Goodman specially for mine service. On specific cars, motors use identical and interchangeable motor shells and armatures.

Your Goodman sales engineer will be happy to explain how you, too, can get trouble-free transfer of payloads with Goodman shuttle cars.

All Goodman cars are built for easy positioning under loading boom.

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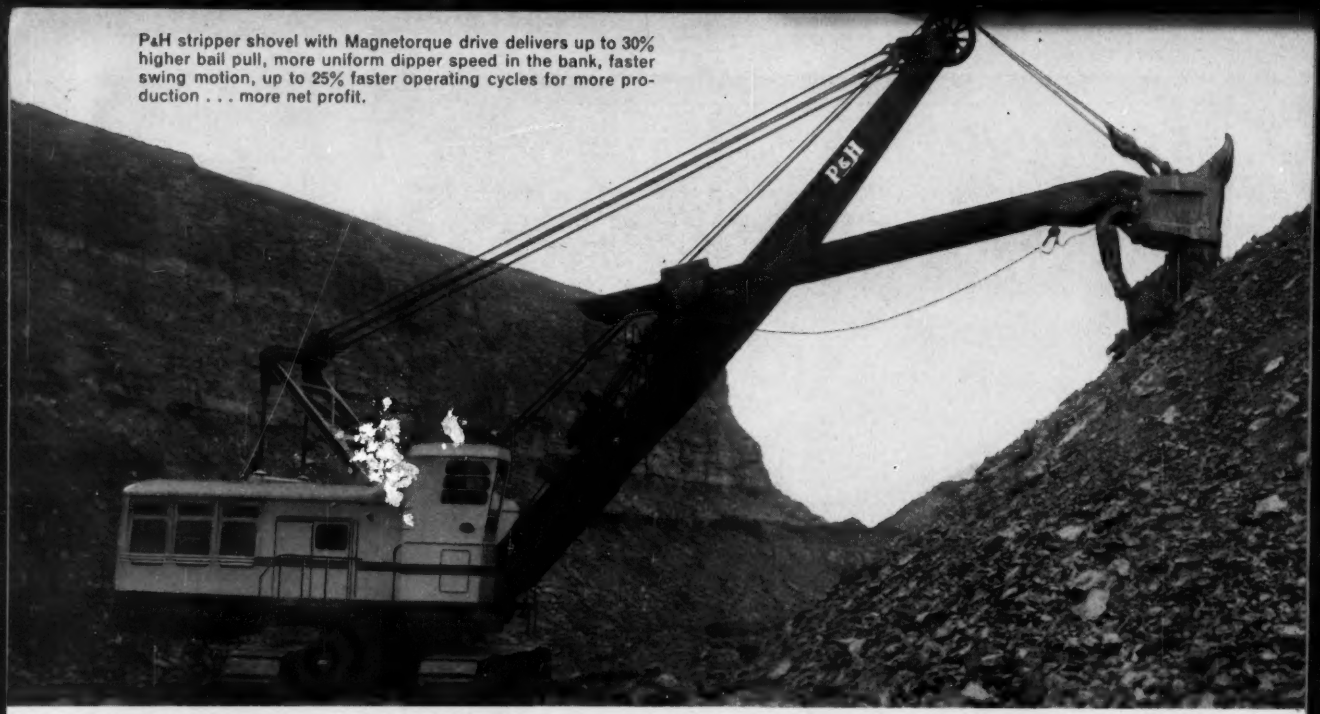
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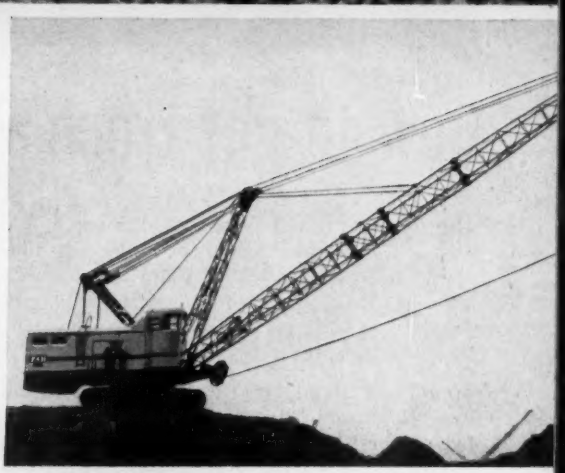
Use Genuine Goodman Replacement Parts

P&H stripper shovel with Magnetorque drive delivers up to 30% higher ball pull, more uniform dipper speed in the bank, faster swing motion, up to 25% faster operating cycles for more production . . . more net profit.

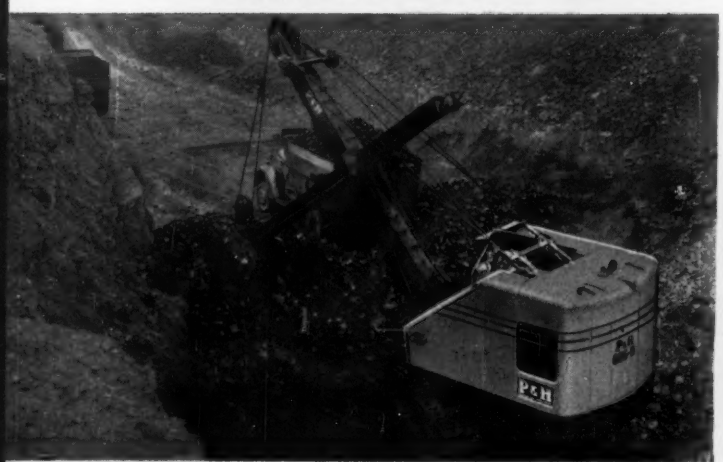




3½-yard P&H diesel excavator features long crawlers and Magnetorque drive for swing and propel motions. Equipped with 48-ft. boom and a 34-ft. dipper handle for economical stripping operation.



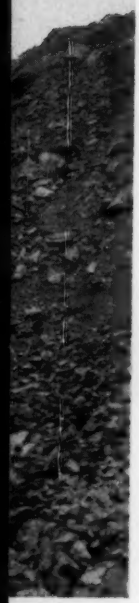
P&H 1855 is fully convertible for long range dragline service. It is the largest excavator mounted on a single pair of crawlers—unmatched for maneuverability.



1¼-yard P&H excavator loads coal into trucks. Exclusive P&H Magnetorque drive for swing and propel motions delivers the smoothest, fastest, most accurate swings and "move ups" known in the industry.



Versatile P&H truck crane for handling material at mine siding and a variety of utility jobs. Highly mobile unit features quick, easy change-over of front end attachments—from crane, hoe, dragline, shovel, clamshell.







It pays to standardize on P&H...

P&H WITH MAGNETORQUE® DRIVE GETS DOWN TO COAL FASTER... LOADS IT OUT QUICKER

It's good business to standardize on P&H electric shovels and draglines, diesel excavators and truck cranes for all your needs . . . big, medium or small . . . There's a size and type for every job.

Full-Electric and Diesel-Electric Shovels and Draglines from 3½ to 10 yards—Big, rugged electrics that deliver up to 10% more production with exclusive MAGNETORQUE drive—the most productive work-motion drive known for mining excavators. The system that electro-magnetically transmits driving energy of the power plant (A.C. electric motor or diesel engine) direct to the work motions, without intermediate conversion to D.C. current.

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Versatile Truck Cranes from 12½ to 80 tons—Highly maneuverable, powerful truck cranes that keep your big crawler excavators free for production . . . Mobile units ideally suited for handling secondary road-building, refuse disposal, drainage, erection, maintenance and 101 utility jobs. . . . Truck cranes that can be changed in the field to any front-end attachment quickly, easily and without special tools.

See for yourself why more mines today are standardizing on P&H equipment. There is a reason . . . Harnischfeger offers you more advanced designs, new concepts in engineering that pay off in increased production and lower operating costs.

Compare before you buy—write today for more information.

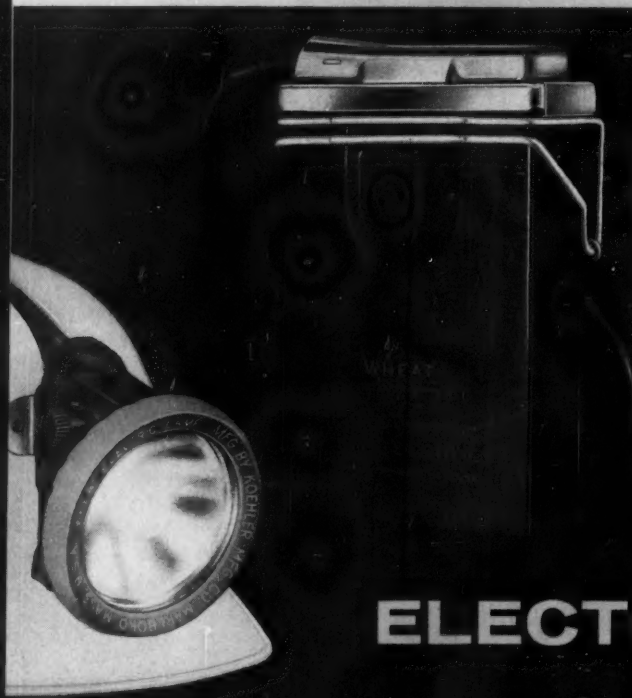
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–and here are the bedrock reasons why:

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SIMPLEST MAINTENANCE FOR LOWEST COST
Ordinary cleanliness, weekly watering and occasional bulb replacement are the simple maintenance requirements of the Wheat National. There are no covers to open, no terminals to clean, no valves to free, no cells to re-solution, no lamps to rack. Wheats need a minimum of manual attention.

Write for WHEAT Electric Cap Lamp Bulletin No. 593—free on request.

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Devoted to the Operating, Technical and Business Problems of the Coal-Mining Industry

COAL AGE

JULY, 1960

IVAN A. GIVEN, EDITOR

Building for Gains

In a little less than a year and a half, the National Coal Policy Conference, internally and externally, has achieved a working implementation of the "common-voice" approach to industry problems for which it was formed.

Internally, through numerous planning sessions, the NCPC high command—representing coal management, UMWA, electric utilities, equipment manufacturers and coal-carrying railroads—has implemented the common voice by demonstrating a unity of purpose believed unique in American business enterprise today, submerging or resolving differences for the sake of common goals of promoting the welfare of coal and establishing its rightful place in the national economy.

Internal unity is attributed by Mr. Moody to the fact that NCPC's high command is composed of seasoned executives, long familiar with coal problems and interests, who have risen to positions of top authority at the same time. For each, seasoning has meant a deepened awareness of his group's stake in a healthy, prosperous coal industry; a deepened awareness of the futility of inter-group warfare; a deepened awareness that maximum progress for each group comes through forging a united front to attack common problems.

By achieving internal unity, NCPC has created a force for external acceptance hitherto unparalleled in coal's history. When NCPC needs to confer with top officials in the Interior or State Departments, for example, a morning phone call will bring an afternoon meeting. Not so long ago, coal industry groups seeking high-level government audience were frequently met with dilatory tactics, or, on occasion, were given an unadulterated brush-off.

Aside from upgrading industry stature with government officials, NCPC can also point to positive "acceptance" gains with competitive fuel groups. In the fight for control of residual-oil imports, NCPC's solidarity has been a major factor in setting up a quasi-alliance with certain domestic oil producers. There are also signs that a similar quasi-alliance with some Midwest gas producers and pipeline companies is in the making to fight common problems arising from imports of natural gas from Canada.

On balance, NCPC can point to real gains in establishing the framework or climate which will eventually lead to more satisfactory solutions of industry problems. But, withal, NCPC is under no illusions. The fight for a national fuels policy, and for fairer treatment on residual oil imports and dump gas, will undoubtedly be with us for some time to come. How long this time is will depend in no small degree on how solidly all coal men back this new powerful force for accelerating industry progress.

If coal is to win its rightful share of projected demands for a vastly expanded energy market, it must undertake "a great new emphasis on research . . ."

Projected Energy Demands vs. Potentials for Bituminous

(Millions Net Tons)

Year	Est. Total Energy Needs, Bituminous Coal-Equiv.	Possible Shares of Total Energy Market for Bituminous Coal					
		30%*	35%	40%	45%	50%	65%
1960	1,779	533	622	711	800	889	1,156
1965	1,990	597	697	796	896	995	1,294
1970	2,238	671	783	895	1,007	1,119	1,455
1975	2,530	759	886	1,012	1,139	1,265	1,645
1980	2,863	859	1,002	1,145	1,288	1,432	1,861

*In 1955, estimated total energy requirement in bituminous coal-equipment was 1,573 million net tons; bituminous coal supplied 29.9%.

Source: "Outlook and Research Possibilities for Bituminous Coal," USBM, May, 1956.

Research: New Catalyst for Coal Growth

Stymied in the 50's and unsure of the 60's, coal should take serious stock of this new approach to growth: "Don't wait for it; invent it." Coal's current research and future needs reviewed. Action program proposed.

By **W. A. Raleigh Jr.**
Associate Editor, *Coal Age*

IN ITS JAN. 23, 1960, issue, *Business Week*, a McGraw-Hill publication, featured a special 12-p report to the Nation's executives entitled, "The United States Invents a New Way to Grow." Coal executives and industry leaders seeking new patterns of growth might well take a serious cue from the article's keynote, briefed as follows:

"Most fundamentally, economic growth means growth in a Nation's underlying ideas and skills. The immediate generator of economic growth is investment. Partly, investment is set in motion by economic forces. More basically, investment arises from new ideas, new developments in science and technology, from education, from research. Innovations—new products, new processes, new resources—are the real seeds of long-term economic growth.

"Now the U. S. has made a fresh contribution to this growth process. Americans have discovered that these innovations need not be the accidental, sporadic things of the past. By a great new emphasis on research, by systematizing innovation—industry and government now make regular provision for the occurrence of new and unpredictable developments. This process is just beginning. But already it is furnishing the kind of spur to growth that came earlier from such individual developments as railroads, electricity, automobiles."

BW's message bears close heed by coal because both its record of economic growth and general attitude

toward research leave much to be desired.

Consider, first, a few highlights on the economic record:

The industry can point with just pride to a certain type of outstanding economic gain during the past 10 yr. Its product has been almost unique in the American economy for having resisted the general upward spiral in prices. At year-end 1959, the average mine price of coal stood at an estimated $4.75, compared with $4.84 in 1950.

The price feat was accomplished while the average daily wage (excluding fringe benefits) rose a total of $10.20 during the 10-yr period. It was made possible by rapid advance in mechanization, a general boost in productivity from 6.8 to 12.6 tpd and aggressive cost-cutting programs which included gains in safety, maintenance and mine engineering. It was accompanied by a continuing improvement in the art of preparing quality products from an ever-widening range of coals.

During this same period, however, and in spite of almost unique price advantages, industry production and sales have fallen. Average output for the 5-yr period, 1950-54, was 473 million tons; in the past 5 yr, 1955-59, output averaged 456 million tons.

Although a handful of companies operating in specially advantageous geographic locations or market situations enjoyed sustained progress during the past decade, these central facts remain: The industry has experienced no net production growth, and profit margins, generally slim, have reduced ability to generate new capital for modernization and expansion.

Now, in the wake of 410-million-ton years in 1958 and 1959 and with 1960 production estimated at 430 million tons, talk has increased about the tough job "in the immediate years ahead." And some experienced observers, carefully evaluating acute competitive problems and rapidly changing technological trends in coal markets, are setting 500 million tons as a reasonable target for 1965.

Consider, second, a few highlights on the research record:

Here again coal can point to outstanding achievement. In the mining, preparing and marketing of coal, there are numerous new methods and equipment for increasing capacity and efficiency—continuous-mining systems, giant shovels and haulage trucks, automatic preparation plants, and long-distance conveyor and pipeline transport, to mention only a few. In utilization, BCR-developed equipment—the automatic Coal-Pak and Coal-O-Matic boilers, the Fire-Jet stoker and the Easy-Flo Bin—should be included among major gains.

But when these achievements are measured in terms of who has been paying the bill, there is less cause for pride. Government agencies, coal producers and related industries spent an estimated $17.5 million on coal research in 1956 (the latest available year for such figures). This was about 0.7% of the year's gross sales volume, put at $2.5 billion. Actually, this expenditure, when compared on a similar investment-vs-sales percentage basis, was in line with other large-volume, low-margin-of-profit industries, states Dr. Robert L. Savage, vice president, research, North American Coal Corp. But he adds:

"The alarming part of the situation is not that the amount of research on coal is so small, but that the amount of research by individual companies is such a small part of the total. Of approximately $17 million spent for research and development in 1955, 31% was from state and government funds, 18% from equipment manufacturers, 28.5% from other industrial sources and only 21% from coal-producing companies. In other words, coal producers have been relying on the research work of others and, in some cases, the results are not available to the coal companies for future use."

Inadequate support of research by the coal industry is further evidenced by its general lack of interest in commercializing research results. The fact was underscored at last year's BCR Techno-Sales Conference by Dr. Robert L. Savage, vice president-research, North American Coal Corp. (*Coal Age*, June, 1959, p 155); it was stressed again at this year's NCA meeting by NCA Research Director James R. Garvey (*Coal Age*, July, 1960, p 118).

Adding up the pluses and minuses in coal's economic-growth and research records, this much is unmistakably clear: If coal is to win its rightful share of projected demands for a vastly expanding energy market, as estimated in the table above, it

Toward New Emphasis On Research

TO UPGRADE coal's research program, *Coal Age* suggests the following broad lines of action:

1. Initiate an educational program (a) to promote a better understanding of why research is vital to the growth process, and (b) to gain greater acceptance for its key role in fighting competition today and tomorrow. As put by an experienced coal research executive:

"No company, large or small, should undertake a research program unless there is a reasonable possibility of solving by the research method the problems that are posed. At the same time, the management of a company must realize that research is not a magic process which will guarantee immediate returns. Results from a research program are generally slow and costly, and the program should be considered as a continuing long-term investment rather than a luxury to be indulged in only when profits are good.

"The need for a research program must be recognized by an alert management because the real long-range competition in an industry is at the research level. If a company fails to conduct sufficient research, or if it errs in selecting objectives, one of its competitors may beat it to the solution with the same product or even a better product."

2. Seek to expand research in all major categories—resources, properties, mining, preparation, marketing and utilization. In particular, stress resources and properties—categories which have been slighted in the past but which are now of critical and growing importance to all others.

3. Aim for better evaluation and coordination of the total research effort—better evaluation to ensure maximum results; better coordination to avoid duplication and expedite attainment of goals.

Fortunately, two current developments give concrete promise of kicking off implementation of these recommendations. H. R. 3375—providing for a new Office of Coal Research under the Department of the Interior—is a near-sure bet for enactment in the current session of Congress. Meanwhile, reorganized NCA has pledged maximum financial support to its new research division which now incorporates Bituminous Coal Research, Inc.

Bituminous Coal Research . . . The Current

Coal Resources and Properties

USBM — Basic studies aim (1) to analyze the structure of coal and its derivatives; and (2) to develop international coal- and coke-testing standards.

Illinois State Geological Survey

- Integrated long-range program seeks to evaluate properties which influence behavior of coal in any process or treatment. Program includes studies of botanical construction, coal- and coal-ash content of Illinois coals, plasticity, oxygen-containing structures, and wettability of coal surfaces.
- Coal-test logs and other continuing basic resource studies are underway to evaluate Illinois coal reserves realistically, provide keys to exploration, and increase knowledge of geologic conditions surrounding coal deposits.

TVA — Comparative appraisals of various coal resources seek to assist in planning coal supplies for existing plants and in locating future additions to generating capacity.

Ohio State University

- Underway is a long-range systematic study of seven coal beds which account for 95% of present Ohio production. Thorough analysis of chemical and physical properties of each bed aims at developing reference inventory for present and future mining, preparation and utilization needs. Meigs Creek No. 9 completed; Kittaning No. 5 now under study (jointly with Ohio Geological Survey).

Extensive study seeks better methods for analyzing and testing physical and chemical properties of coal. Study stresses methods not provided for under national standards. Key projects, conducted in close cooperation with ASTM, include determination of total sulphur, forms of sulphur, and chlorine in coal.

Carnegie Tech. — Studies on polymeric structure and composition of coal.

West Virginia University — One study aims to find in coal or blends a physical property for predicting coke quality; another seeks to determine and control moisture and ash variations by using dielectric measurements.

University of Alabama

- Developing data on resources and properties of lesser-known Alabama coals. Aim is to aid new industries seeking relatively minor amounts of coal, or coals with special properties.

To determine suitability of Alabama coals as chemical raw materials, one study focuses on chemical reactivity of coal as shown by oxidation, etc.; another on petrographic composition and coal preparation problems.

U. of Kentucky — Surveying some Kentucky coals, mapping seam thicknesses, outcrops, distribution and structure.

Virginia Polytechnic Institute — Making several studies of coal deposits and geologic structures to help guide coal exploration and development in Virginia and adjacent states.

Other projects and aims are: (1) permeability of coal to gas—to improve knowledge of how gas flows through coal beds, (2) washability of Virginia coals—to study possible development of lesser-known beds, (3) coal properties at high temperatures in oxidizing and inert atmospheres—to obtain data which may lead to wider and more efficient use of coal.

Bituminous Coal Research, Inc. — Researching and promoting new and improved test methods. One key project—development of a bench-scale control test for determining oxidation of treated and untreated coals—may be specially useful in stockpiling, thermal drying, etc.

Mining and Safety

USBM — Projects include potential applications of hydraulic mining to American coals; formation and control of acid mine-water; explosives testing; improved techniques and equipment for roof control, face ventilation, mine lighting, and detection, recording and removal of methane and other gases; fire prevention and fighting.

Illinois State Geological Survey — Geologic study aims to develop methods of evaluating mine-roof quality through analysis of diamond-drill cores.

West Virginia University — With Christopher Coal Co., studying emmission of combustible gases from Pittsburgh coal bed and exploring possible means of mining gaseous coal seams more safely and economically. Another project seeks to correlate developments and experiences in roof-bolting with characteristics of the anchorage and supported strata.

University of Kentucky

- Determining if heat treatment of roof bolts will increase their strength sufficiently to permit using smaller-diameter bolts, and relative costs if this can be done.

Virginia Poly-Technic Institute — Several studies to improve safety are concerned with (1) effects of clay minerals on action of shales in coal-mine roof, (2) strength of coal pillars, (3) rockbursts and bumps, (4) effect of re-use on strength of roof bolts, (5) drainage and recovery of methane from coal beds, (6) methods and materials used to construct ventilation stoppings in coal mines.

Also being studied is the structural strength of coal-mine floors. Aim is to provide data for improving overburden control and design of mine roadways.

Alabama Power Co. — Developing a dust counter which can be easily carried underground for use in each working place under prevailing conditions.

Con. Coal Co. — Studying improved mining methods and machinery to reduce mining costs.

Program . . . Where, What, Why

Mellon Institute	A continuing research program, in its 14th year, aims at improved methods for controlling acid waste-discharges from coal mines and preparation plants (sponsored by Coal Industry Advisory Committee to Ohio River Valley Water Sanitation Commission).
	Preparation
USBM	Projects objectives are (1) to increase efficiency of, and set performance standards for, washing and other processing equipment; (2) to determine best operating conditions for kerosene and froth flotation; (3) to improve methods for freezeproofing lignite, and (4) to develop washability data on American coals, especially metallurgical.
Illinois State Geological Survey	Studies aim (1) to determine possibility of "enriching" coal in certain petrographic constituents by selecting particular sizes of prepared coal, and (2) to evaluate source of water-soluble minerals in prepared coal and determine if these can cause "staining."
University of Washington	Developing basic operating data in use of the dense-medium cylone for coal preparation in fine-size range.
	Studying effect of high-polymer flocculating agents on fine coal and associated impurities—may help to minimize stream pollution (in cooperation with Northwest Experiment Station, USBM).
U. of Kentucky	Studying the feasibility of increasing facilities for beehive coke production.
Ala. Power Co.	Seeking use of washer refuse for making aggregates. Also developing flotation agent for recoving 60-mesh coal from strip operations.
Pittston Clinchfield Coal Sales	Researching fine-coal recovery (1) to increase production of high-grade low-ash and low-sulphur coal, and (2) to clean up plant water circuits, thus reducing potentials for stream pollution.
Bit. Coal Res., Inc.	Seeking methods for continuous determination and control of coal moisture.
	Exploring new approaches to more efficient removal of sulphur from steam coals.
Natural Resources Research Institute	Studying preparation and properties of activated carbons from western coals.
Illinois State Geological Survey	Storage, Handling and Transport Study being concluded evaluates amount and rate of deterioration of high-volatile Illinois coal when stockpiled.
Con. Coal Co.	Work aims to reduce transport costs through improving methods of pipelining coal.
Eastern G. & F.	Investigating improvements in coal handling facilities.
Bituminous Coal Research, Inc.	Developing pneumatic coal-handling system whereby one prime mover will serve multiple pick-up points, thus reducing costs of multiple-unit installations.
	Field-testing BCR Easy-Flo Bin which provides self-emptying and continuous flow of coal under all conditions.
	Researching a reliable means, acceptable to shipper and customer, for sampling multiple car-lot shipments of coal to waterside dumping locations.
	Combustion and By-Products
USBM	Basic combustion studies aim (1) to increase the efficiency and extend the flexibility of coal-burning equipment; (2) to explore potentials for coal-fired gas turbine in stationary power plants; and (3) to develop processes for sulphur-dixoide removal from flue gas.
Illinois State Geological Survey	Long-range program aims to determine how mineral constituents in coal affect boiler-fouling and corrosion.
TVA	Projects include studies of potentials for (1) fly-ash use in cement manufacture, and (2) removing iron-oxide particles from fly ash to produce furnace-feed material for steel industry.
West Virginia University	Studying possible economic use of fly ash in highway construction (sponsored by State Road Commission of West Virginia an U. S. Bureau of Public Roads).
Va. Polytechnic Inst.	Investigating effects of using coal as fuel in piston engine.
Bituminous Coal Research, Inc.	Developing ash-removal stoker to combine with other automatic units of coal-fired package boilers. Stressing equipment for size ranges up to 10,000 lb of steam per hr. Aim is total package priced to compete with oil-fired units of same rating.
	Studying data on factors affecting coal's plastic and coking properties. Objective is to improve design and increase efficiency of combustion equipment.
	Evaluating economics and promising new methods for controlling atmospheric contaminants in flue gases.
	Exploring chemical and physical properties of fly ash so that electric utilities can extend profitable uses, thus reducing net cost of coal.

Bituminous Coal Research . . . The Current

Babcock & Wilcox Co.		Various studies on coal behavior encompass ignition, ash, and corrosion characteristics. Aims are to improve design, operation and capacity of steam-generating equipment, and to permit use of new varieties of coal.
Combustion Eng.		Researching grindability and abrasivenes of coals to supply data essential to pulverizer development and use.
		Evaluating ignition characteristics of coal to improve design, efficiency and safety of boilers.
		Studying corrosion of boiler equipment parts by flue gas from coal. A joint project with utilities seeks to eliminate such problems by upgrading coal.
		Carbonization and By-Products
USBM		Basic studies aim (1) to determine carbonizing properties of American coals, coal components and blends, (2) to economically upgrade low-temperature chars to liquid fuels and valuable chemicals, and (3) to develop pitch-coal solutions as road binders.
West Virginia Geo. Survey	●	Project objective is to determine how the quality of coke is affected by the petrographic constituents and dielectric constants of coals from several seams.
Ill. Geo. Survey		Continuing studies conducted on blending Illinois coals to produce metallurgical coke.
West Virginia University		Studying reaction kinetics of hydrocracking and thermocracking of lignite tar fractions. Aim is economic upgrading of low-grade coals by cracking their tars to produce chemicals (USBM Graduate Research Assistantship.
		Researching separation of olefines from saturates found in neutral oil of low-temperature tars. Objectives are to identify compounds and develop commercially useful separation methods (USBM Graduate Research Assistantship).
University of Utah		Using infrared absorption spectrometer to determine nature of chemical bonds changing during coking.
	●	Evaluating products obtained from low-temperature carbonization of high-volatile coals. Aim is to determine product distribution as function of heating program, and, in turn, provide guide for maximum economic return to an operator.
U. of Kentucky		Surveying char, oil and gas yields of Kentucky coals when subjected to low-temperature carbonization.
Consolidation Coal Co.		Exploring new and improved methods of making a better coke or carbon. Objective is to increase efficiency of coal-use in steelmaking, and to upgrade and extend available coal reserves.
Eastern Gas & Fuel Associates		Objectives of comprehensive program are to extend knowledge of coking coals and the coking process, and to improve testing equipment and techniques.
	●	Key projects are studies of (1) effect of changes in blend on analytical and physical characteristics of coke produced and (2) relationship of changes in coking procedures, such as rate of heating, to coking pressures and to coke quality.
Pittston Clinchfield Coal Sales Corp.	●	Projects aim at (1) cataloguing and evaluating coking characteristics of domestic and foreign coals, (2) improving present test ovens to provide more exact measure of carbonization pressures, an (3) analyzing oxidation effects to upgrade coal for carbonization, and to study related storage, handling and usage problems.
Peabody Coal Co.		Researching new products for company's Mansfield carbonization process. New Peabody-Wright Corp. to study combination of this and Curtiss-Wright processes for making coal-based road-paving binder.
North Amer. Coal		Studying carbonization of coal to obtain premium fuel and chemical products.
Pittsburgh Coke & Chemical Co.		Seeking (1) higher-value products from coal-tar pitch and coke-oven gas, and (2) an economical low-capital-investment process for making coke-oven benzol competitive with petroleum benzol.
		Studying low-temperature oxiation of coal for better understanding of "coking" and "charring" of coal (jointly with Bituminous Coal Research, Inc.).
Koppers Co.		Researching the preheating of coal for carbonization. (Results of work on high-oxygen coals published in *Blast Furnace and Steel Plant*, June, 1959).
Battelle Institute	●	Project focuses on use of tar from low-temperature carbonization of Texas lignite. Sponsor, Texas Power & Light Co., reports prototype carbonizer, installed at Alcoa's Rockdale Works, has provided operating data and design characteristics.
		Evaluating effects of coal size and processing on high-temperature coke strength. Aim is to develop data for equipment and process changes.
Mellon Institute		A program in its 26th year continues basic studies on new uses for by-product coke chemicals.
		A program in its 12th year continues research on industrial plants of Koppers Co. Notable recent results have pertained to improved methods for testing and analyzing process waste waters.
Southern Res. Inst.		Studying carbonization of coal in a fluidized bed to obtain engineering design data.

Program . . . Where, What, Why

Natural Resources Research Inst.	● Synthetic "coke" project seeks a substitute metallurgical coke from Western subbituminous or high-volatile bituminous coals.
	Conversion to Gases and Liquids
USBM	Aim of gasification program is more efficient means of converting coal to purified synthesis gas. Projects include (1) application of nuclear heat to gasifiers, (2) methods of feeding coal to gasifiers, (3) operation of slagging gasifier, (4) studies of kinetics of coal-steam reactions and oxidation of low-rank coals in liquid-water media with air or oxygen.
	Objective of hydrogenation program is to develop process and design data for producing liquid fuels, high-Btu gas and chemicals. Methods under study are (1) hydrogenation of dry coal or char, (2) steam-coal reaction, (3) hydrocarbonization of coal at high pressure, and (4) hydrogenation of carbon monoxide and related synthesis.
West Virginia University	Analyzing flow characteristics of coal-water slurries to improve design of transfer equipment for coal-gasification processes. A project associated with use of nuclear heat for gasification is evaluating effects of particle size and pressure on gasification of some cokes, chars and subbituminous coals in a coil reactor.
Alabama Power Co.	● Project focuses on making uneconomic or marginal coal useful via underground gasification Coal would be converted to synthesis gas for use in petro-chemical industry and, in enriched form, as substitute for natural gas.
Cons. Coal Co.	Studying conversion of coal to liquids and gases to increase large-volume markets for coal.
North Amer. Coal	Researching gasification of coal to obtain premium fuel and chemical products.
Institute of Gas Technology	Continuing long-range program aims at developing new source of high-Btu gas via gasification or hydrogenation of coal (*Coal Age*, May, 1958).
Combustion Engineering, Inc.	Surveying possibilities of new coal uses through, for example, low-temperature gasification with char and tar production.
Natural Resources Research Inst.	Studying (1) better use of mine refuse and fly ash, and liquid fuels via hydrogenation of low-temperature coal tars.
	Other Projects
Illinois State Geological Survey	Continuing evaluation of economic factors vital to coal industry, such as, fuels-use in manufacturing, potentialities of direct reduction of iron ore, etc.
	Revising mined-out-area maps.
U. of Kentucky	Surveying quality of clays found with Kentucky coals. Analyzing production costs, ownership structure, and employment changes in state's coal industry.
Va. Polytechnic Inst.	Supplying data to industry on application of industrial engineering to coal mining.
Eastern Gas & Fuel Associates	Studying (1) better use of mine refuse and fly ash, and (2) market and competitive trends for coal, coke and related products.
Pittston Clinchfield Coal Sales	Researching possibilities of upgrading waste coal shales for use as construction materials.
North American Coal Corp.	● Laboratory- and pilot-plant program aims to economically produce high-purity aluminum oxide and/or sulfate from cleaning-plant refuse.
	Another project seeks low-ash and low-sulphur coal from commercial coal grades.

● Bullets denote projects rated by reporting authority as most likely to bring early benefits to coal.

must undertake "a great new emphasis on research."

Essentially, the new emphasis means accepting research—not as a luxury or incidental function—but as a major and basic part of total operations. For coal, it also means upgrading research aimed at strengthening existing and developing new markets—although not to the point of sacrificing expenditures on other components which support the total merchandising structure.

To aid coal in shaping new emphasis on research, *Coal Age* suggests broad lines for an action program in the panel on this page. Also offered for industry appraisal is the following survey of coal's current research program and future needs:

Current Program

To gain some evaluation of immediate- and long-term research needs, *Coal Age* first sought to determine the scope of programs currently being conducted by federal and state agencies, universities, coal and coke producers*, trade associations, independent research groups and equipment builder asking two questions:

1. In what coal-research projects is your organization now engaged and what are the objectives of each?

2. Which current projects (specified

* Not included were most captive coal producers who, for policy reasons, do not usually publicize research projects.

in Question No. 1) do you consider most urgent in terms of benefits they may bring in the mining, preparation, marketing or use of coal?

Replies summarizing bituminous projects are listed in the running panel, p 80-83.

The anthracite program, including an evaluation of priority projects, is briefed on the facing page.

Except for a relatively few cases noted with bullets (•) in the running panel, researchers generally shied away from pinpointing "most urgent" projects. Behind this reluctance are two main factors:

1. Individual research organizations are inclined to consider all their projects vital or related to each other. Stated otherwise, no project would be researched unless it were deemed to incorporate an element of urgency or to have relativity to overall research aims.

2. By its very nature, research neither guarantees results nor time requirements to achieve possible results —therefore, evaluation in terms of immediate benefits is inherently risky.

Several respondents, however, saw fit to express their views on the need to expedite research as follows:

T. Reed Scollon, chief, Bituminous Coal Div., USBM—Hydraulic mining merits urgent classification. The use of hydraulics in the extraction of coal from the solid offers a novel mining method with obvious safety factors. It appears to have particular application under geological conditions that are not conducive to conventional, mechanized-mining methods, namely, steeply pitching beds, very thick beds and very thin beds.

The use of pipelines to haul coal away from the face to the surface preparation plant deserves more intensive study. While tremendous strides have been made in coal-mining methods, the rapid removal of broken coal away from the face and subsequent haulage to the surface has not kept pace with improved mining methods. Consequently, the full potentials of mining systems have not been realized in many instances.

If hydraulic mining is used, the further use of water to move the coal underground has immediate advantages. Even where conventional mining is practiced, the transport of coal to the surface by hydraulic means may be economic. The movement of coal in pipelines, a commercial success in the transport of fine coal, would have greater application if economic means could be developed for the hydraulic movement of coarse coal.

The coal-fired gas turbine, with its recognized improved cycle efficiency over the conventional steam cycle, may markedly increase the use of coal for power generation. To achieve this goal, further development in design of the coal-burning gas-turbine plant is needed to enable it to fulfill the long-life requirements of stationary plants.

James Westfield, assistant director, Health & Safety, USBM—Research areas deemed urgent are:

1. Roof control projects. The largest number of coal-mine fatalities occur from roof falls and control of roof constitutes a major coal-mine operating expense. Improved roof-support techniques and inspection will reduce fatal injuries and greatly improve operating efficiencies.

2. Ventilation of continuous mining machines. Technological progress, with the development of new equipment necessitating concentrated mining, has complicated face ventilation problems. New concepts must be accepted, and development of special ventilating auxiliaries of suitable pressures and volumes must be expedited.

3. Solution of the float-coal dust problem. This problem is serious from both safety and efficiency standards. Modern concentrated mining releases large volumes of fine coal dust which, if allowed to settle as airborne dust in back entries, constitutes a definite explosion propagation hazard. Additional rock dusting does not provide adequate protection unless done often. Clean-up is expensive and curtails efficiency.

Future Needs

To gain some picture of future needs, *Coal Age* asked research authorities the following third question:

3. In your opinion, what broad areas of coal research should get more emphasis in the future and briefly state why. (Areas are defined as follows: coal resources, mining, preparation, storage and transportation, combustion, coke and chemicals, gasification, physical and chemical properties.)

Respondents were generally more willing to express their views toward future needs than toward pinpointing "most urgent" current projects. Considered in total, however, replies, either implicitly or explicitly, reflect equal reluctance to push one area of research at the expense of others and thus show no common pattern of emphasis.

Replies were as follows:

Eric H. Reichl, director, Research and Development Div., Consolidation Coal Co.—Coal's main use will remain conversion to electric power. Everything possible should be done in this field to combat inroads of other fuels.

This means more emphasis on radically new methods of mining, preparation and transportation. An example would be the maximum application of hydraulics. Equally important is increased research on all phases of the sulphur and ash problem to solve the increasing air pollution problems associated with coal in power stations.

As far as chemicals are concerned it is worthwhile to recognize that the industry as a whole simply can not expect any significant coal market from this area. A great deal of technical effort must precede production of chemicals while the volume in terms of tons per year is small.

Graham Granger, vice president, Eastern Gas & Fuel Associates—Joint engineering-economic studies with the electric utilities and their equipment suppliers and consultants should get more emphasis. Such studies are needed to better cordinate future expansion of coal production with anticipated increases in demand for electricity. The cooperative program on control of atmospheric contaminants and sulphur reduction sponsored by AEIC, EEI and BCR is a start in the right direction that might be usefully expanded.

Milton H. Fies, consulting engineer, Coal Mines, Alabama Power Co.—As our reserves of gas and petroleum become less plentiful we shall need a gas from coal, enriched, to replace natural gas as a synthesis gas for utilization in the petrochemical industry. The Russians, according to English scientists who have studied underground gasification in Russia, report success in this field. It is a mistake to disregard this work in the U. S. on the grounds

that we can presently produce mined coal on a much lower cost basis than underground gasification. We should accept the premise that we shall gain from what the Russians and British are doing.

For the same reason, it is vital to know more about low-temperature tars and the use of coal gas in gas turbines.

An experimental effort which will improve maintenance of underground machinery and the handling of coal from underground mechanical units to enable producers to take full advantage of the capacity of such machines would be most helpful.

C. R. Montgomery, carbonization engineer, Pittston Clinchfield Coal Sales Corp.—In the long run, gasification should be stressed more. This field can give us gas and chemicals needed as basic raw materials for the future, even if at present not economically feasible. Research is needed to be ready when called on to tap basic raw materials for chemical synthesis.

In our thinking, gasification should be a government project. The cost is too great for it to be done by coal companies which can gain nothing in the foreseeable future with gas and heavy oils drawing the realization on coal down to where many coal companies are forced to sell out or close up business through bankruptcy.

All research fields should have a problem carried on but certainly resources, storage and mining are now so far ahead we need to know more about how to use coal rather than how to produce it. We are wasting millions of tons per year of a valuable resource, because of lack of an overall policy coordinating industry and government planning for the future.

Dr. R. L. Savage, vice president, research, North American Coal Corp.—More emphasis should be placed on improving the marketability of coal by converting it to higher-value fuels or by making it a more economically transportable fuel. Improved marketability of coal is of extreme importance to the industry to retain its competitive position.

Charles C. Russell, Research Dept., Koppers Co., Inc.—Higher priority is needed for studies on physical and certain chemical properties of coal from various coal seams at various locations. The available data on specific gravity, specific heat and heat conductivity of coals is very meagre. Also more data is desirable on the ash composition of various coals—especially on the rarer elements.

Dr. Ernest O. Ohsol, Pittsburgh Coke & Chemical Co.—For the general future use of coal, we would consider further mechanization of the mining and transportation of coal as being of the greatest importance. Future uses may well be at major plants located in mining centers where coal would be converted (1) to methane for pipeline transportation when the price of natural gas rises, as it eventually must, and (2) to electric power for super-high-voltage transmission.

Jack A. Simon, geologist and head, Coal Sec., Illinois State Geological Survey—It is strongly felt that much work remains on studying the properties of coal which may influence combustion characteristics. An area of considerable study, but one that needs more emphasis, primarily concerns mineral constituents in coal and their relationships to problems of air pollution, boiler-fouling and corrosion, slagging characteristics, etc. Increasing use of coal for generating electric power make these relationships of constantly increasing importance.

Ira S. Latimer Jr., geologist, West Virginia Geological and Economic Survey—More study is needed to gain fuller understanding of the com-

Anthracite Research . . . USBM's Current Program

USBM is carrying the brunt of hard-coal research. As reported by R. E. Corgan, acting chief, Anthracite Div., most urgent, in terms of possible benefits they may bring to the industry, are projects which aim:

1. To obtain fundamental data on reactions of anthracite with hydrogen, steam, or other fluids in producing gaseous hydrocarbons.
2. To determine and define basic chemical and physical properties of anthracite.
3. To evaluate the effects of radiation on anthracite, including the effect of gamma radiation on reactions of anthracite, with selected chemicals to form commercially valuable products.
4. To develop a highly productive, fully mechanized system for longwall mining of anthracite beds of from 3 to 7½ ft thick, and pitching 15 to 25 deg.

Rounding out USBM's comprehensive program are projects which aim:

1. To develop and thoroughly test an anthracite briquet for use in metallurgical furnaces.
2. To investigate the use of calcined anthracite in other than blast-furnace and cupola processes.
3. To study the direct conversion of anthracite energy into electricity via the fuel cell.
4. To investigate possible methods of producing ultrafine anthracite in the 50 to 5,000 A-size range and to compare properties of these particles with carbon blacks of the same particle size.
5. To evaluate the most suitable crushing and grinding equipment for producing rice and smaller sized anthracite from domestic sizes.
6. To study use of high-velocity cyclones and heavy-media processes for recovery of fine-sized anthracite.
7. To provide data on washability characteristics which can be used for present preparation processes and for preparation of new anthracite products.
8. To determine how low-ash anthracite can be prepared for use as an industrial fuel or industrial carbon raw material.
9. To study the technical and economic feasibility of, and equipment design for, a hydraulic hoisting system.
10. To explore new concepts that may develop during research on the processing or use of carbonaceous materials.

position and nature of coal itself. Basic research must provide the facts upon which applied research and eventual coal utilization depend.

Research is also needed to help improve coking methods and quality, and to explore new uses for chemicals extracted from coal.

William E. Dean Jr., Power Research Staff, TVA—We feel that a thorough inventory of the Nation's coal resources (which should be kept up-to-date), plus further research into coal's physical and chemical properties, are basic to a comprehensive research program. For example, longer-range mining-research projects should be guided by an accurate understanding of what is left to mine. Effective research in combustion problems can be better planned if the physical and chemical properties of remaining coals are well understood. This also applies to chemicals derived from coal.

Ernest M. Spokes, College of Engineering, University of Kentucky—Mining should get continuing research to improve recovery and safety and to reduce costs. Coke and chemicals should be studied to develop (1) new uses for coal products, and (2) the use of coke as a fuel. The latter is important to justify increasing coke capacity, and thus the production of coal chemicals as markets are enlarged. Physical and chemical properties should be investigated to support these types of applied research.

Dr. George R. Hill, Fuels Engineering Dept., University of Utah—Research on coke and chemicals, and physical and chemical properties, should be stressed. Chemicals from coal are more varied and intrinsically more valuable than those from petroleum, yet no coal-chemical industry comparable to the petrochemical industry exists. Research lack is one basic difference.

Reynold Q. Shotts, professor, Mining Engineering, University of Alabama—Physical and chemical properties, coke and chemicals, and coal resources merit high research priority. The first two are placed high on the list because we must know more about the substance, coal, before we can hope for a breakthrough in new uses. Resources are important for the next decade or two because the big coal use and market will be electric utility fuel. Nearly all kinds and types of coals can be used for such fuel but we need to know more about their locations and quantities, and the mining conditions. Combustion research is important, too, but again our best chance for improving combustion efficiency is probably through knowing more about the substance, coal.

W. A. Koehler, director, Engineering Experiment Station, West Virginia University — It is difficult to select one or more of the areas mentioned for special emphasis if such emphasis is to be obtained at the expense of the others. Basically, there are two general fields to be considered: (1) production and processing, and (2) utilization.

In many existing and potential markets coal will be required to meet its competition on a cost-quality basis and thus mining, preparation, storage and transportation all become important research areas.

Coal gasification and the synthesis of gas products are very important to the future utilization and market strength of coal. These areas should figure heavily in the coal-research program, as also should fundamental studies on physical and chemical properties.

The near future merits considerable study of fuel cells using coal directly as a fuel anode.

Charles T. Holland, professor and head, Dept. of Mining Engineering, Virginia Polytechnic Institute — I would put research on coke and chemicals, gasification, and physical and chemical properties in the same general category. As such, this category should get the most emphasis since herein lie the keys to developments which may lead to important new markets.

However, it should be kept in mind that research in all areas can improve coal's position.

Dr. R. C. Ulmer, Combustion Engineering, Inc. — Certainly research and development in preparation is bound to get more consideration. Present methods are physical in nature. They do not affect alkalies and other harmful constituents in coal. Corrosion studies, such as those now being carried on by Combustion Engineering (see panel p 82), will point to certain constituents that are harmful. Then it will become desirable for coal companies to furnish coal without these constituents.

Much research will also be done on combustion. This is necessary from the burner-design standpoint and possibly also from the corrosion standpoint. In the past this research has been done by the boiler manufacturers. Coal companies should assume part of this work; in fact, I believe it will become imperative to do this if coal is to maintain its present position in the field.

P. R. Grossman, director of research, Babcock & Wilcox Co.—Gasification should be stressed because the use of gas for boiler or gas-turbine firing reduces maintenance, corrosion and power requirements. Initial costs for gas-fired units are much less than for coal-fired units.

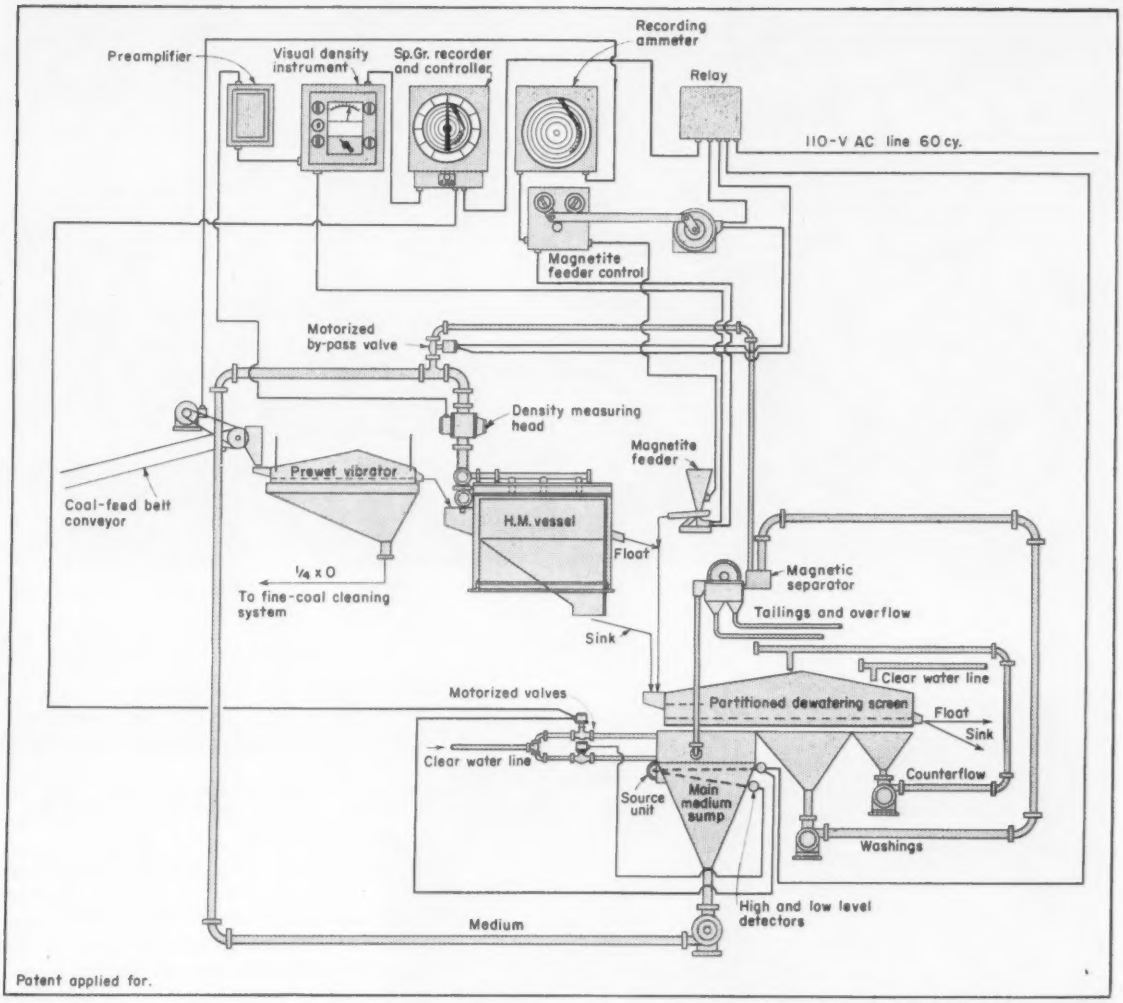
Equally important is more study of coal's physical and chemical properties. Unless the behavior of coal ash can be predicted from analyses the costly procedure of "over-designing" must prevail to obtain reliable performance in the boiler field.

James R. Garvey, director of research, Bituminous Coal Research, Inc.—Greater research effort is needed in the solution of problems inherent in the use of coal in the rapidly growing electric utility industry. Increasing equipment size and concentration of plants will require more knowledge of the causes and control of fireside deposits and the emission of atmospheric contaminants. While such research will be directly related to combustion, it will probably be necessary to increase research on the physical and chemical properties of coal to obtain sufficient basic information for satisfactory solution.

Richard B. Engdahl, division chief, Thermal Engineering Research, Battelle Institute—The following areas of research require more intensive study:

1. Gasification, because this frees coal from its impurities as well as from its limitations as a solid.

2. Ash behavior in combustion equipment, because ash limitations restrict coal applications.



CONSTANT, accurate control of the operating gravity in the heavy-medium system at Underkoffler Coal Service is a fully automated process. The closed-loop control maintains specific gravity within a range of a plus or minus 0.003.

Automatic Density Control

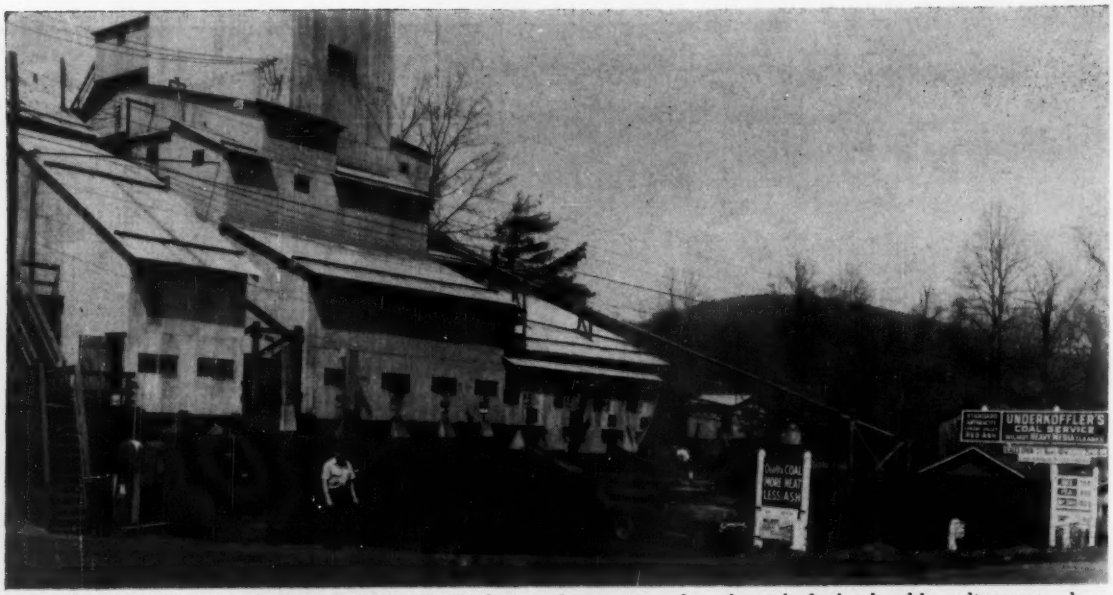
Gamma-ray radiation devices detect variations in specific gravity in a flowing stream of medium.

Resulting electrical signal initiates corrective steps, on the instant and automatically.

PINPOINT ACCURACY in maintaining the operating gravity of a magnetic suspension is the main feature of the modernized anthracite preparation plant of Underkoffler Coal Service, Lykens, Pa. Control of the specific gravity of the bath, within a range of plus-or-minus 0.003, involves the use of gamma-ray radiation to measure the density of the medium and to initiate corrective impulses when the density varies from a preset value.

The Wilmot-OCC heavy-medium system replaces a jig washery at the Underkoffler plant, with the result that average ash content of the prepared coal is consistently 10-11% against 12-16% ash in the product of the old washery. Total yield is greater since there is no misplaced coal in the refuse, and plant labor requirements are minimized because the heavy-medium system requires no attendance.

Development of the specific-gravity control system (patent applied for) was a venture of Wilmot Engineering Co., using instruments of Brown Instruments Div. of Minneapolis-Honeywell Regulator Co., and Industrial Nucleonics Corp. Compo-



UNDERKOFFLER'S ANTHRACITE SUPERMARKET features fast service and ample stocks for local and long-distance truckers.



STOCKPILES of clean coal are laid down on plank floors to prevent contamination. Reclaiming includes rescreening at structure in center distance.

nents include AccuRay equipment, recorders, controllers and motorized valves. These devices are employed as follows:

The AccuRay density-measuring head operates on the principle of radiation absorption being proportional to the mass penetrated by the rays. The radiation source and detector are a unitized installation in the medium-inlet pipe leading to the vessel. This construction makes it relatively easy to replace the unit in the unseemly event that something should go wrong.

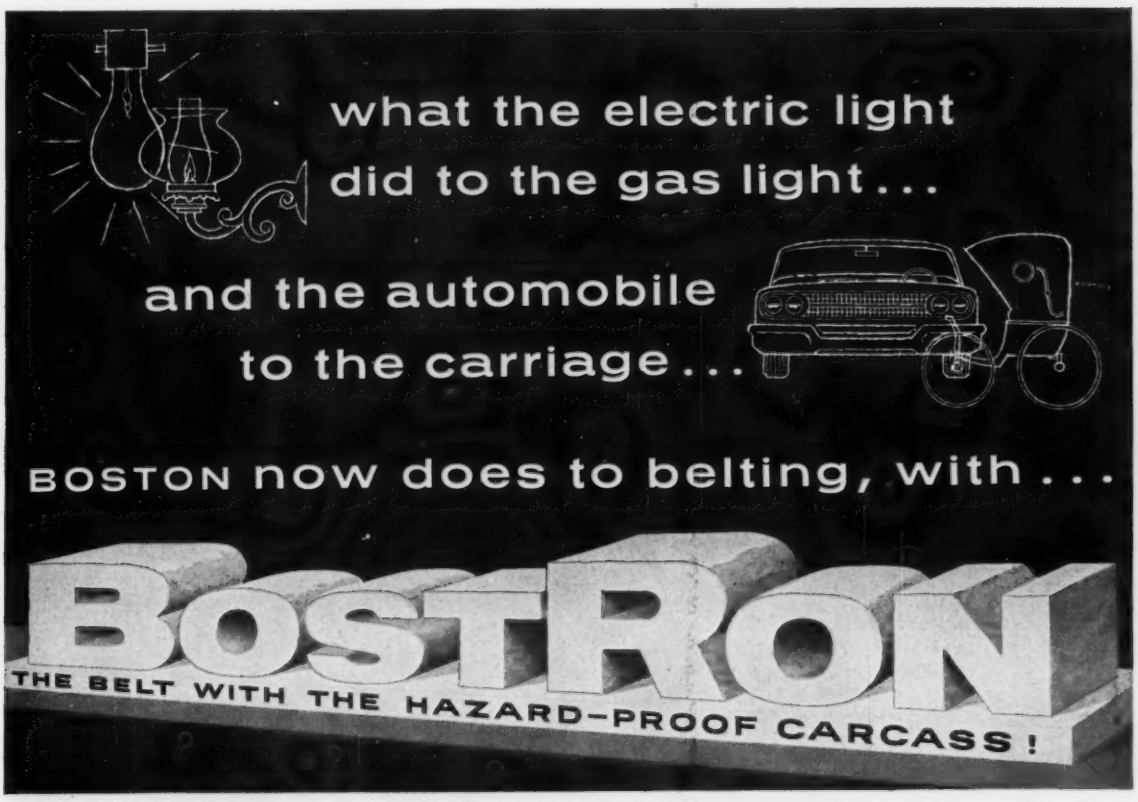
An electrical signal from the radiation detector (see accompanying control diagram) is amplified and used to print a continuous record of the density of the medium on the Honeywell-ElectroniK recorder-controller. This signal also actuates the corrective processes of adding dilution water or stepping up the magnetite densification rate—whichever is needed — to adjust the gravity to the preset value.

The controlling function is performed by a Honeywell-Electr-O-Line proportioning unit which is an integral part of the ElectroniK instrument. The proportioning control operates two final elements — a motorized valve in the medium-bypass line and a Modutrol motor which in turn operates a rheostat in the magnetite feed circuit to control the rate of feed of the medium.

Also in the control system is a visual density instrument by which the density of the bath may be changed at will through the turning of a knob on the face of the instrument. The amplified signal from the AccuRay head first passes through this visual density instrument. If there is any error in the density the visual density instrument provides a DC output (from minus 5 to plus 5 millivolts) which is fed to the recorder-controller to initiate the necessary correction.

A recording ammeter measures and records the current drawn by the coal-feed conveyor motor. When the load on the conveyor is reduced the ammeter automatically stops the magnetite feed system, since when the pre-wet feed stops there is no moisture entering the system, thus no magnetite is required.

The recorder-controller also governs an additional motorized valve through which fresh water is admitted to the main medium sump if the operating gravity becomes too high. A second AccuRay instrument is employed at the main sump with two detectors to control the level of the medium in the sump. Note in the diagram that the underflow of the partitioned drain-and-rinse screen is caught in a three-compartment sump.



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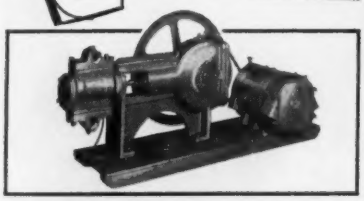
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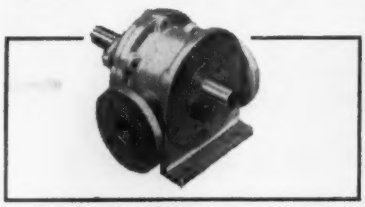
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Gathering Type PLUNGER PUMP—dependable, light, compact. Has many uses. Pipe connections are brought into proper position by reversing suction and discharge chambers. 42" long, 17" wide, 22" high, weight (less motor) 260 pounds.



High Pressure SPRAY or FIRE PUMP—round stainless steel rollers prevent clogging and jamming by coal and dirt particles. Uses less power—friction is reduced. Produced in various capacities—10 GPM at 100-125 PSI for spraying. 50 GPM at 50 PSI for fire needs.

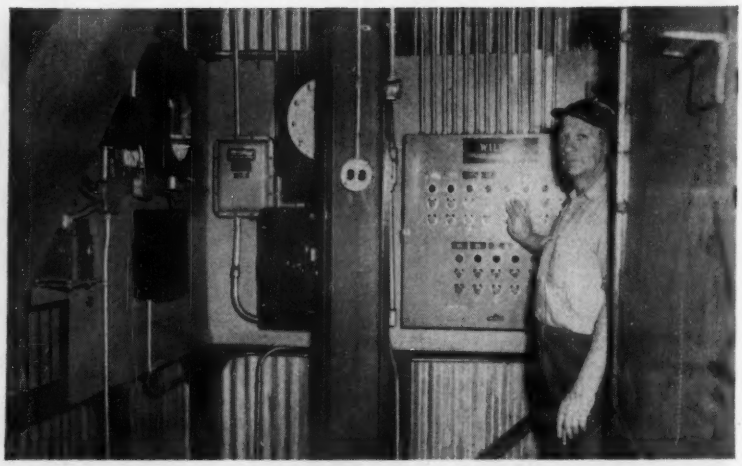


CENTRIFUGAL PUMPS highly rated for complete reliability and service. All sizes to 8" discharge and 1500 GPM. In acid-resisting bronze or stainless steel.

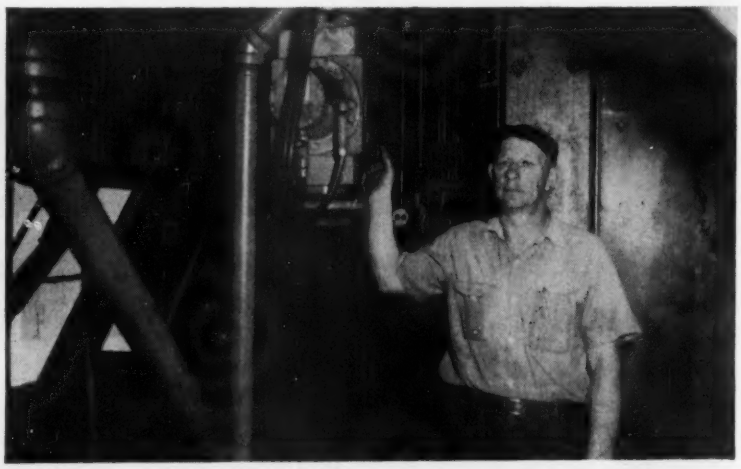
PUMP REPLACEMENT PARTS for practically all types and makes of centrifugal and plunger pumps.

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Sales Agent: Kanawha Rail & Machinery Co., Charleston, W. Va.



HERSCHEL UNDERKOFFLER, owner and manager of the plant, shows automatic density control instruments (above) and density measuring head (below) in medium inlet pipe leading to the vessel.



The third compartment, at the discharge end of the screen, provides water for the washing sprays.

The Wilmot automatic density control system at the Underkoffler plant eliminates the possibility of human error in controlling the specific gravity and the consequent fluctuations in product quality. It provides instantaneous correction and constant surveillance of the system. The operating gravity is selected from a calibration curve which is based on prior washability test of the coal to be cleaned. Changes in gravity to achieve certain desired results may also be taken from the curve.

Herschel Underkoffler, owner and manager of the plant, points out that one man operates the entire cleaning plant. Raw coal is purchased from independent miners in the area. The products of the plant include all sizes from Stove down to the extreme fines, Buck Nos. 5 and 6, with all plus ¼-in material being cleaned in the Wilmot vessel. Nominal feed rate is 75 tph.

The plant is situated on U. S. Route 209 at Lykens, and is equipped to provide fast service to local and long-distance truckers. During the summer months a supply of clean coal will be built up. The Underkoffler stocks are laid down on a base of planks to prevent contamination. A reclaiming structure in the stockpile yard is equipped to re-screen the coal prior to loading. A Hough Payloader and Farquhar elevating conveyors retrieve the coal from storage to fill orders as they are received.



How to simplify lubrication underground

By using *multipurpose* oils and greases, you can drastically reduce the number of lubricants needed for your underground equipment. In some mines, Texaco Lubrication Engineers have even gone so far as to set up an effective lubrication program using only two lubricants!

Think what a simplified lubrication plan like this could save you—in storage and handling costs, in reduced inventory and, above all, in eliminating the dangers of misapplication. And—you could ask no better assurance of dependable, uninterrupted production and lower maintenance costs.

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UNION



The High I. Q.* Wire Rope Organization

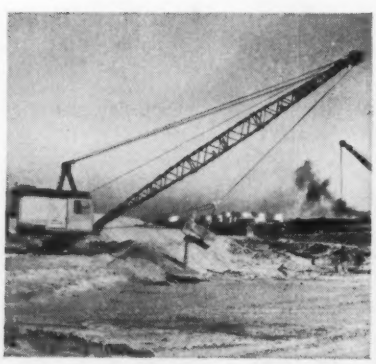
**Integrity — Quality*

More and more purchasing agents are employing a new concept in buying called value analysis. In it the integrity of the seller weighs heavily since it assures maintenance of uniformly high product quality.

Advanced procedures and equipment in Union's foremost laboratory enable our technicians to determine the life expectancy of wire ropes. Much of the time of our engineers is spent in the field checking to see that Union wire ropes live up to or exceed predetermined life expectancy rating under varying operating conditions.

In living with wire ropes and slings from the cradle to the grave, our engineers found new constructions were necessary. On many of the tougher jobs the life expectancy of standard wire ropes of the highest quality was too short. To equip the machines handling these tough jobs with the ultimate low cost wire rope and slings, Union developed the Tuffy family. Each member is a special construction tailored to fit a special purpose. For many years Tuffy's ultimate low cost wire ropes and slings have helped battle the rising cost of operation.

Tuffy Wire Ropes and Slings Are Tailored For Tough Jobs



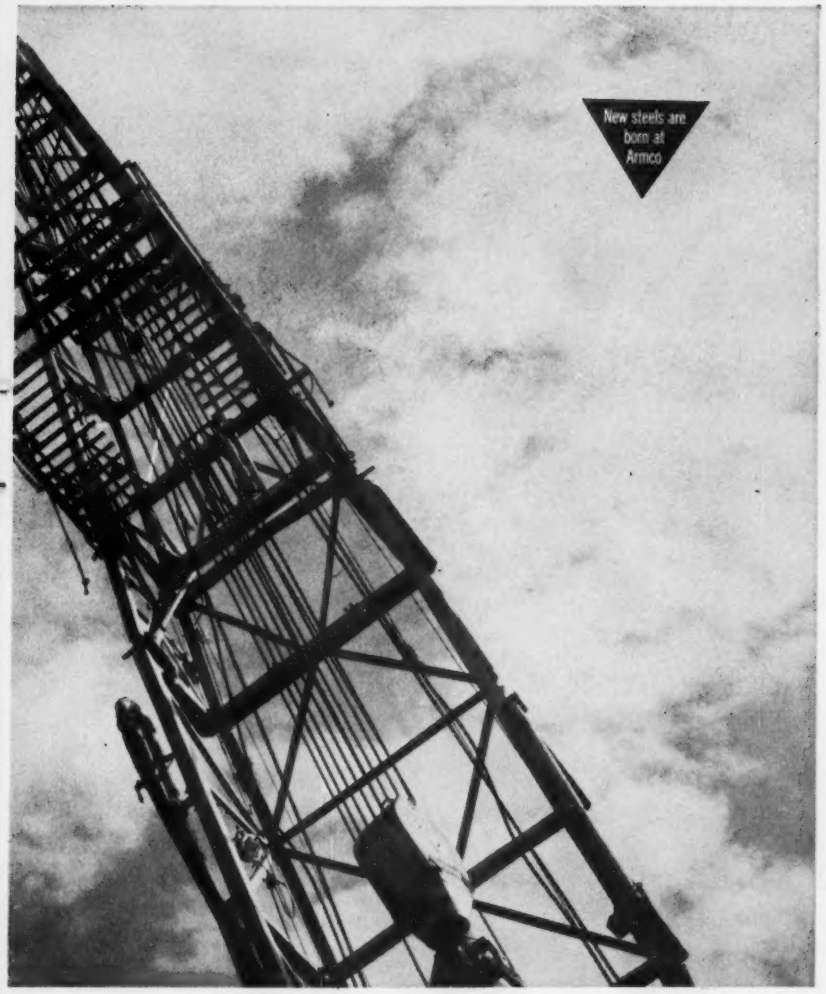
Tuffy Balanced Dragline Rope



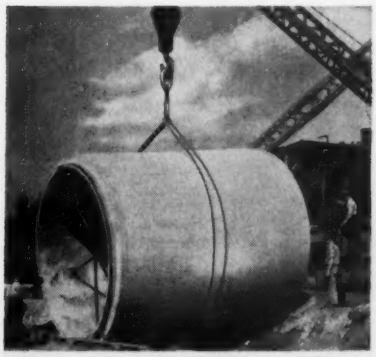
Tuffy Balanced Scraper Rope



Tuffy Balanced Dozer Rope



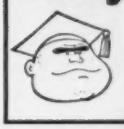
Wire ropes travel hundreds of ton-miles on rotary oil drilling rigs lifting and lowering drill pipe and tools out of and into the hole. On the world's deepest oil well Tuffy Rotary Line handled the longest string of well casing ever run. The final live load totaled 700,000 lbs.



Union Distributors Are Selected On High I. Q. Standards

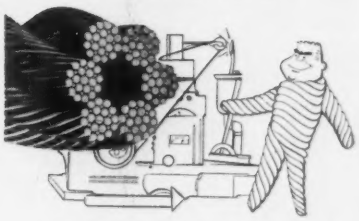
They know from experience that they can serve you with quality backed by integrity and enjoy a high expectancy for your repeat business. Look up your Union Wire Rope distributor in the yellow pages of your phone book. He is coached in helping you before and after the sale. Backing him up is an expert staff at a nearby Union Wire Rope branch office and warehouse.

Tuffy Wire Rope Tips



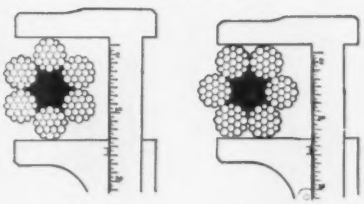
Money-Saving Information on the Use and Care of Wire Rope

Wire Rope is a "Machine" of Moving Parts



...and every part must fight destructive forces! A "look inside" a section of wire rope reveals a precision assembly of working parts. They are subjected not only to external and internal stresses, but also to heavy surface pressures and abrading. All these forces may be sustained while the rope is running at high speeds, and abruptly changing direction. That's why different uses require different constructions of wire rope.

How to Measure Rope Diameter



Right Way *Wrong Way*

There's only one right way: Use machinist's calipers, and be sure to measure the widest diameter. A slight shift of the rope in the calipers (shown at right above) might cause ordering an undersize rope.

How to Measure Tread Diameter



Easy, and important. Select the smallest sheave or drum to be used with the new wire rope, and measure actual diameter at lateral center (shortest dimension) of tread.

Would you like a copy of a booklet in which more than a score of Tuffy Tips like those above are reproduced. If so, write Union Wire Rope Corporation, 2130 Manchester Ave., Kansas City 26, Missouri.

Tuffy Balanced Slings and Hoist Lines



3-C

UNION Wire Rope

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Macks keep coal

Comin' down the mountain

Twenty degree grades — hairpin turns — gumbo mud when the weather's bad — a tough test for trucks and drivers — the kind that Macks take in stride. From a mountain-top mine near Van, West Virginia, Bunch Construction Co. had to move coal down to a tipple on the valley floor.

Terrain conditions made conveyors out of the question, so they cut a roadway up the face of the mountain and put a fleet of big Mack L Models on the job.

Day-in and day-out, with drivers working in shifts, the giant trucks load quickly at the drift mine, snake their way down the steep twisting grades to the dump site and grind right back for more. This is the heaviest kind of duty for any truck, but it's just one of the punishing jobs that a Mack does so well.

In mining, in quarrying, in logging, in construction or in oil field work — wherever there's a really tough job to be done — Macks are invariably called upon to handle the assignment. They have the ruggedness and stamina . . . the sure-footed power to lick the toughest terrain. Where ordinary trucks bog down, break down or require excessive maintenance, the extra margin of protection against shock loads, stresses and strains that's built into every Mack component pays off over and over again. Find out first hand what a Mack can do for your operation by checking with your nearest Mack branch or distributor. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

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MACK
FIRST NAME FOR
TRUCKS

Loading at mountain-top mine. Big L Model Macks take on 30 tons at a time from high-speed conveyors and are on their way again in minutes.



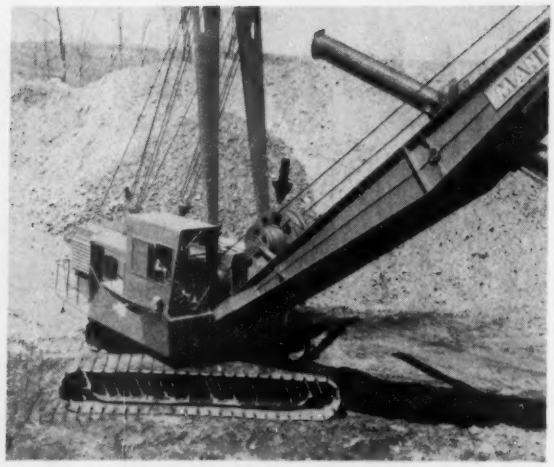
MACK
for over 7 straight years
NO. 1
by far in sales of diesel trucks

Another thirty tons of coal arrive safely at the dump site. On tough jobs the world over, Mack dumpers prove they are built to handle every assignment with little or no downtime and only routine servicing.



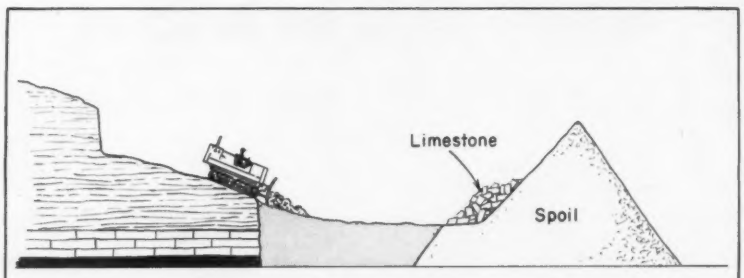


NEW 5-YD SHOVEL incorporates design innovations making possible faster operating cycles with less operator fatigue.

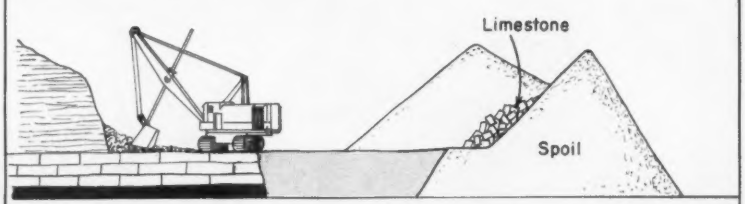


REDUCTION DRIVE mounted on the base of the boom has separate hoist lines leading to either side of shovel bail.

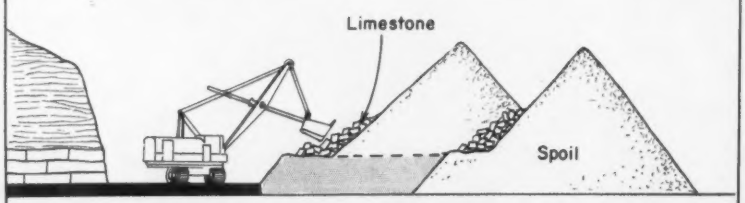
Two-Engine Diesel Shovel Paces



Step 1--Bulldozer cuts down upper 10 to 15 ft of shale, makes bench fill across pit to spoil from previous cut.



Step 2--Shovel removes remainder of shale to expose limestone covering coal.



Step 3--Shovel piles up blocks of limestone near foot of shale spoil where they will be covered by material from future cuts or by backfill.

Incorporating new concepts in diesel-shovel design, a 5-yd unit makes possible faster cycles with less operator fatigue. Greatly reduced shovel maintenance is added benefit at Ohio mine recovering 30-in coal.

FASTER operating cycles, less operator fatigue and greatly reduced maintenance costs are three major benefits resulting from application of a new 5-yd shovel at the Hardy Coal Co., Millersburg, Ohio. Incorporating new concepts in design, the Manitowoc 4500 Vicon shovel removes 8,000 cu yd per day to expose the 30-in Ohio No. 3 coal. And in favorable conditions the unit moves considerably more material.

Three-Step Stripping

Hardy Coal removes up to 60 ft of overburden in a three-step opera-



BACKFILLING and leveling of spoil bank with bulldozer covers large blocks of limestone piled up at lower part of spoil. Company plants trees or adds fertilizer and sows grass on spoil to return land to farm use.

Three-Step Stripping at Hardy Coal

tion to expose a 50-ft wide strip of coal. Starting at the top of the coal, overburden includes 2 to 8 ft of limestone that breaks out in large blocks, then 20 to 50 ft of shale. Stripping machines remove this material without the aid of explosives.

Working one shift, a Caterpillar D8 bulldozer equipped with a hydraulic-tilt U blade pushes about 12 ft of the shale into the old pit, making a level bench that extends from the new highwall across the pit to the spoil. The Manitowoc 4500 Vicon swinging a 5-yd Amsco bucket with Esco teeth, then moves in and removes the remainder of the shale, casting it as far as possible and against the spoil from the previous cut. This step leaves the lower limestone bed exposed.

After uncovering a 500-ft strip of limestone, the 4500 returns to the starting point and throws the blocky limestone up onto the remainder of the bench made by the bulldozer in the first step. This three-step method of stripping leaves the large blocks of limestone near the toe of the spoil. On the next cut these blocks are covered with shale from the upper portion of the overburden.

After stripping reaches the 50- to 60-ft limit, the bulldozer levels the spoil area and also pushes part of the shale into the pit. Thus any limestone boulders are covered. The company plants trees on most of the backfilled and level areas but in some instances the land is fertilized and planted with grass and returned to farm use.

The rock in the overburden is high in silica and consequently the shovel dipper is subjected to more than average abrasion. To keep dipper wear to a minimum, the company hardfaces the bottom and half way up the sides with Hobart hard-stain rod. Bucket teeth are replaced every 3 to 4 mo.

The New Shovel

There are two engines in the 4500 Vicon shovel. One Twin Disc torque-converter-equipped Murphy diesel engine provides power for swing, travel and boom hoist. A second larger diesel engine, also fitted with a Twin Disc torque converter, powers the drums. This twin-engine feature enables the operator to perform several functions simultaneously and thus increase operating speeds.

There are no conventional engine throttles. Each clutch-control lever is also a throttle. By pulling or pushing the control lever from the stop position, the operator engages a swing or drum clutch. The further he moves the lever, the harder the machine works in that direction.

Hardy Coal's management notes a significant reduction in maintenance costs with the Vicon shovel, particularly in clutch wear. For instance, 50% or more of the clutch wearing surface remains after more than 10 mo of operation.

Management credits this long clutch life to the fact that there is no slippage when clutches are engaged. The first 10 deg of control-lever-movement does not operate the throttle and, as a consequence, the clutch engages at low engine speed and when clutch and drum speed are nearly zero. When the control lever passes the 10-deg mark, the machinery accelerates through a three-stage torque converter without clutch slippage.

No brakes are needed to stop the swing action because the torque converter provides braking action. It also absorbs or eliminates shock and slip on the swing frictions and provides instant acceleration for the return swing.

With the two-engine system there are a number of advantages. For instance, one engine may be slowed during a particular tough part of the cycle while the other engine is speeded up to take over the next step in the cycle. Also, one engine may be working at top speed while the power of the other is introduced at idling speed to take over the next step. Furthermore, faster cycle time is possible since there is no engine lugging and clutches are not engaged at high and harmful speeds.

The shovel also is designed with separate hoist leading from either side of the shovel bail to the other end



TRACTOR SHOVEL working ahead of coal-loading shovel skims off fine, loose dirt from top of coal. It also performs other miscellaneous jobs around the pit.



LOADING and hauling team includes a 1¼-yd diesel shovel and 18-ton end-dump trucks. Haulage units travel over company roads to nearby tipple.



PREFABRICATED concrete silos store 1½x0 coal for delivery to truck customers serving nearby industrial consumers. One silo holds 100 tons, the other holds 30 tons.



DESTINATION of trucks is 100-ton hillside bin that feeds the tipple.

of a reduction drive mounted on the base of the shovel boom. This feature eliminates the weight and instability of a bail sheave at the bucket as well as bad fleet angles on the hoist cables.

Loading and Hauling

An Allis Chalmers HD9 tractor shovel skims off fine dirt from the top of the coal as the last step before loading begins. A Bay City 65 diesel shovel with a 1¼-yd dipper then loads the coal into two International 18-ton end dump trucks. Powered by 200-hp Cummins NHB600 engines and equipped with Timken tandem drives, these units transport coal 1 to 2½ mi to a 100-ton hillside storage bin.

Coal feeds from the storage bin to a picking table where refuse is removed before the coal passes to a Patton two-stage double-roll crusher. After being broken to 1½x0, the coal is elevated to the top of two Ohio prefabricated concrete storage silos. The company also has two ground storage piles which provide a reserve supply for periods of heavy demand.

All of Hardy Coal's output is sold to truck customers who serve consumers in nearby industrial markets. Management reports that in the near future Hardy Coal will be operating in the Ohio No. 6 seam near Baltic, Ohio.



When there's roof to be bolted... Bethlehem contact men help you test and install



Experienced Bethlehem contact men are ready—anytime—to help you with the original installation and testing of Bethlehem mine roof bolts and accessories.

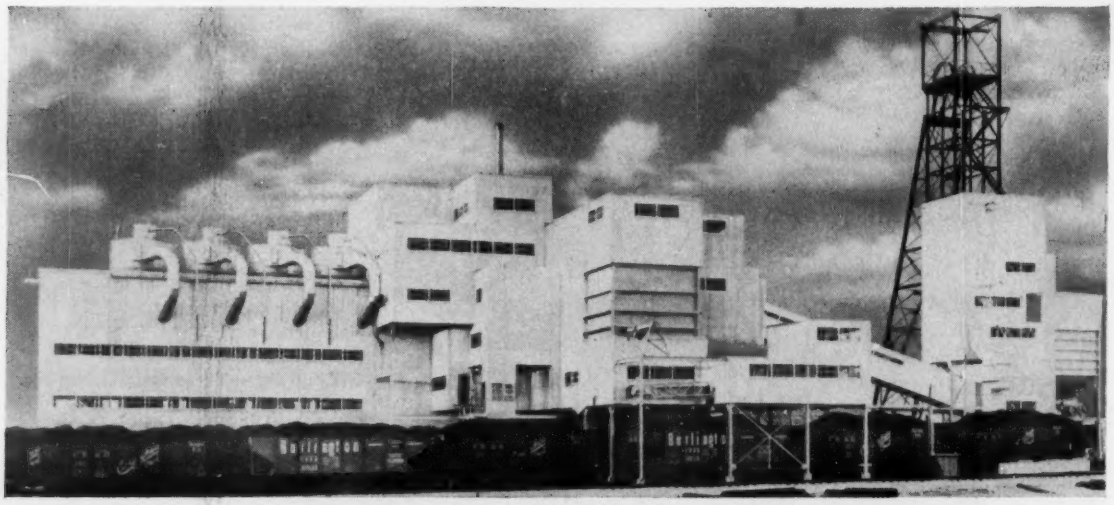
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CLAD IN ALUMINUM and fed by an automatic hoist, the preparation plant serving No. 21, with a capacity of 800 tph, features jig washing of 6x¼, air cleaning of ¼x0, centralized control, and automatic proportioning blending facilities.

New Coal for Midwest Steel

Employing boring-type miners, shuttle cars and belts underground, and automatic hoisting and washing and air-cleaning on the surface, the new Old Ben No. 21 mine serves the growing Middle Western steel market.

THE FIRST in Illinois designed specifically to serve the metallurgical coal market of the Middle West, the new No. 21 mine of the Old Ben Coal Corp., at Sesser, Ill., was officially dedicated June 14. Reserves of recoverable low-sulphur coking coal in the No. 6 seam being mined total 100,000,000 tons. By 1962 it is expected that the production of No. 21 will reach 3,000,000 tons a year, based on 3-shift operation at 5,000 tons per shift, making it one of the largest bituminous operations in the U. S. Coal moves out over the Chicago, Burlington & Quincy, Illinois Central, Missouri Pacific and Chicago & Eastern Illinois railroads to the various markets.

The reserve was purchased in 1918 in anticipation of the eventual shift of the Nation's steel production to the Great Lakes-Mississippi Valley area. Development began with the sinking of the first shaft in April, 1956. The first coal was hoisted Jan. 4, 1960.

Depth to the coal at the location of the hoisting and service shafts, approximately in the center of the property, is 670 ft. Average coal thickness is 8 ft. 2 in, of which 7 ft is taken by the boring-type miners. Consistent banded partings are absent.

Continuous mining, belt haulage and skip hoisting are the basic production activities. Key items in the list of face, haulage and supplementary units include the following.:

Hoisting Shaft—Elliptical in shape, 11x20 ft, 756 ft deep, concrete lining averaging 16 in thick. This shaft is the fresh-air intake and accommodates two 10-ton bottom-dump Connellsville skips. The bottom 90 ft is enlarged for a 100-ton storage bin and automatic skip-loading equipment with electronic weighing in the 10-ton loading pockets following the storage bin.

Hoisting distance is 801 ft 9 in, and operation is completely automatic, using load cells on the bottom and an electronic probe at the top for sensing and control, as shown in the accompanying diagram. Coal is now delivered by belt but provision is made for 16-ton cars at some future date if desired.

The hoist, a Nordberg double-drum unit, straight 9-ft drums, was moved from No. 15 mine. It was one of several electrified by Old Ben a number of years ago. It is driven by a 2,200-hp 110-rpm motor, 600 V DC, backed up by a flywheel set. Capacity is 80 skips per hour. General Electric did the automating job.

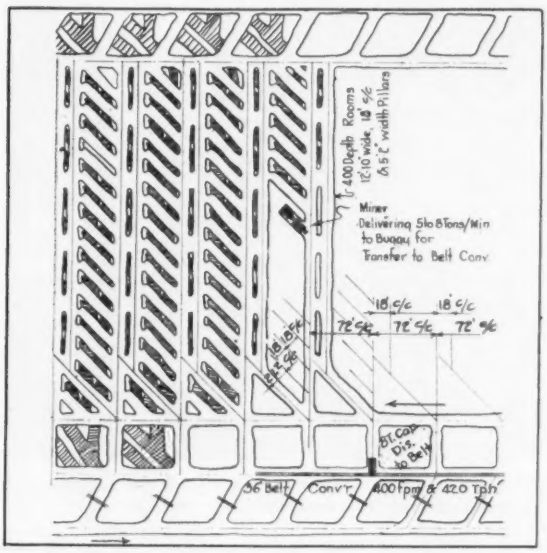
Man-and-Materials Shaft — Like the hoisting shaft the man-and-materials shaft also is elliptical. Depth is 666 ft and shaft size is 30x20 ft, with 16-in concrete lining. A 15-in concrete partition wall divides the shaft into uptake and hoisting sections. The 9½x12-ft cage has a capacity of 50 men. It is operated by



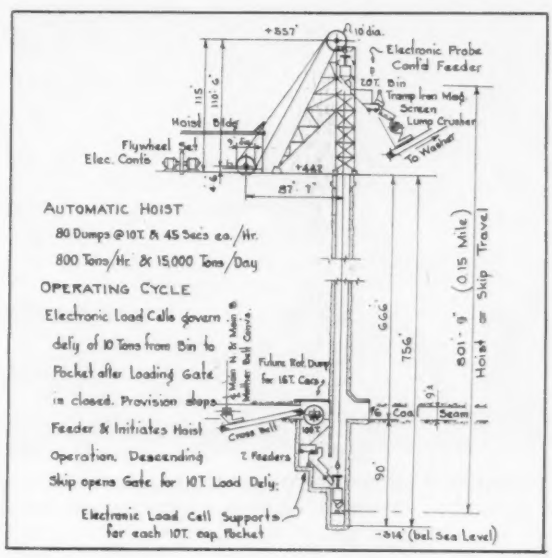
PRODUCTION MAINSTAY is the boring-type miner supplemented by torque-converter shuttle cars, hydraulic roof-bolter.



CHAIN-HUNG ROPE-FRAME CONVEYORS move coal to the storage bin ahead of the skip pockets at No. 21 mine.



TYPICAL MINING PLAN involves pairs of rooms with thick pillars between. Final small fenders are removed by pocketing.



AUTOMATIC HOISTING SYSTEM is based on load cells for the skip pockets and an electronic probe in the dump bin.

a manually controlled straight-drum hoist originally used at No. 20 mine for coal. Maximum travel speed is 600 fpm.

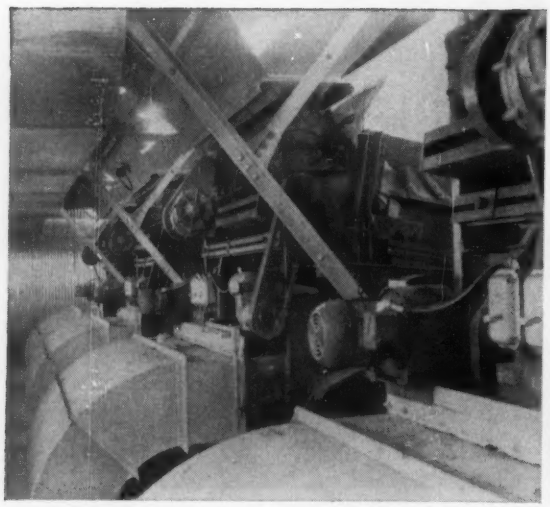
The cage will accommodate all but the largest pieces of mining equipment without dismantling. The big units are swung under the cage, and special brow construction was employed on the bottom to take the units off the cage. The strata were cut away on a 45-deg angle for a considerable distance back from the landing and U-bolts were mounted at strategic points for chain hoists, ropes and tackle to swing the units out into proper position for final lowering.

Both the hoisting and man-and-material shafts were sunk, lined and equipped by Old Ben. Number of man-shifts for the jobs aggregated over 13,000—without a single lost-time injury—under the direction of Reggie Carroll.

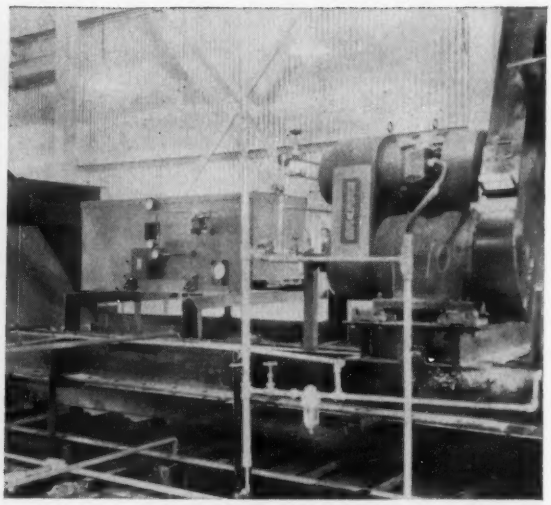
The shafts were started with a clamshell, after which mucking was done by a Joy JPG pneumatic grapple with a ⅝-cu yd bucket.

Ventilation – Air presently is supplied by a Joy Axivane fan with a maximum capacity of 144,000 cfm. Provision is made for a second fan when needed to operate in parallel with the original. Each section of the mine in which a unit is operating has a separate split of air with a minimum delivery of 25,000 cfm.

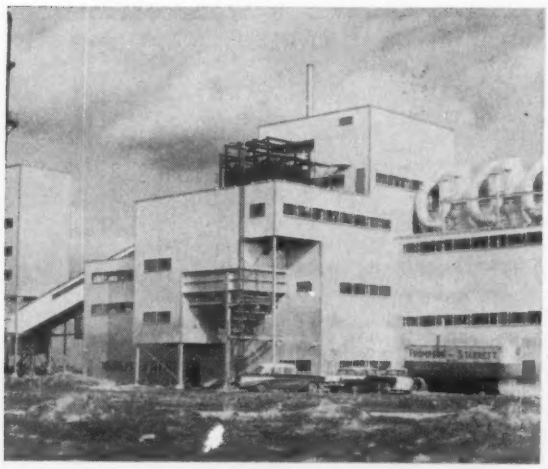
Face Equipment—The basic production unit at No. 21 mine is the Goodman Type 405 continuous miner, 440 V AC. It makes a cut 7 ft high and 13 ft wide, leaving most of the remaining coal thickness in the

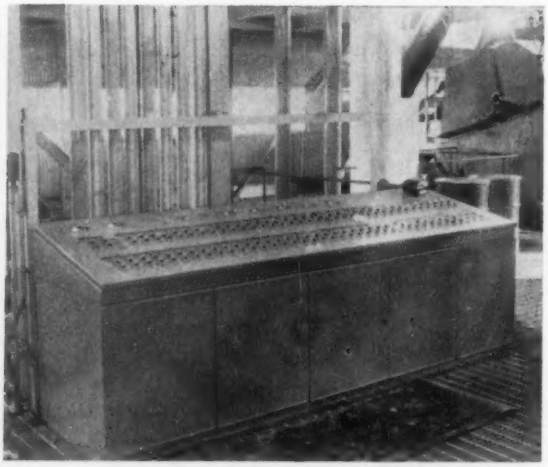


AIR CLEANERS prepare ¼x0 at No. 21, with 6x¼ going to a wet jig.



MEASURING FEEDER maintains ¼x0 ratio in remixing into larger sizes.





ROOF-MOUNTED TRANSFORMERS (left) supply power to motors in the preparation plant. At the right is the central panel controlling all plant operations except loading, which is handled from a center over the tracks.

top to help support the tender shale.

Three National Mine Service Type 48 8-ton TorKar shuttle cars serve each miner and feed to panel belts. Each miner also is accompanied by a Fletcher twin-head bolting unit for placing 5-ft bolts on 4-ft centers.

Rock - dusting facilities include "Red-Necktie" slurry-type equipment designed for mounting directly on the machines.

The basic mining plan to be used at No. 21 is shown in an accompanying diagram. It includes rooms 400 ft deep and a combination of thick and thin pillars removed by pocketing on an angle.

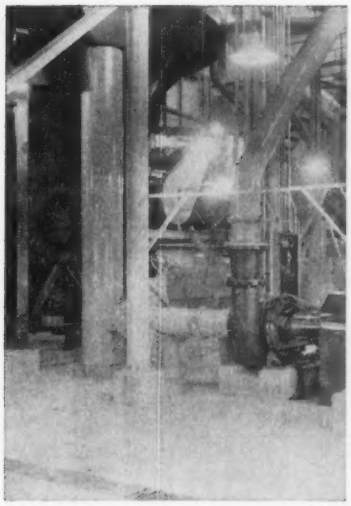
Belt - Transportation — Goodman Ropebelt conveyors with U.S. Rubber belting are used for panel and mainline transportation. Panel belts are 36 in wide, and the mainline belt leading to the shaft bottom is 42 in wide. A track system with Watt cars is installed for supplies.

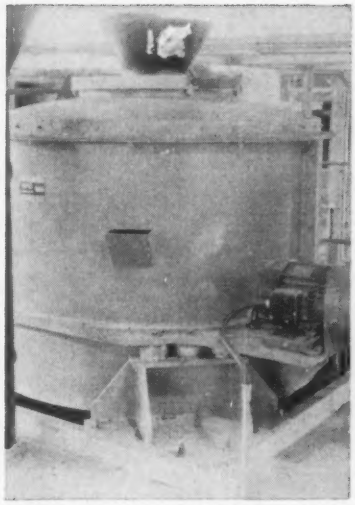
A feature of the belt system at No. 21 is roof suspension on chains. Among the advantages are easier handling of spillage, no interference with belt operation as a result of buildup, and better self-alignment of bottom idlers because of freedom to swing and thus train automatically.

Service Facilities— These include an underground shop near the man-and-materials shaft for the minimum requirements for minor overhaul and repair. Larger equipment and big jobs will be serviced in a central machine shop on the surface.

Power is purchased from the Central Illinois Public Service Co. substation at W. Frankfort through an Old Ben receiving station and is distributed over 33,000-V Old Ben service lines. No. 21 is 21 mi distant from the W. Frankfort installation. Overhead lines at the plant have been eliminated by putting all surface distribution circuits in cable tunnels.

A wash house accommodates dressing and showering facilities, heating equipment, man-and-materials hoist, and rack and charging facilities for the Wheat cap lamps





SUPPLEMENTAL FACILITIES for ¼x0 fine coal and water include a settling tank and pumping equipment (left) and a centrifugal dryer (right).

employed. Separate buildings house first-aid, supply and certain other facilities. All surface buildings were erected by Old Ben.

Heat and hot water (continuously circulating closed-circuit system) is provided by a 100-hp Coal-Pak boiler with fully automatic coal feed and ash disposal.

Water for the mine is obtained from a 170-million-gal reservoir created by damming Jackie Creek on mine property.

Staff — Old Ben, with corporate headquarters in Chicago and operating headquarters at Benton, Ill., is headed by D. W. Buchanan Jr., son of D. W. Buchanan Sr., chairman of the board. Other general officers are Otis V. Gibson, secretary; William C. Campbell, assistant to the president; R. B. Starek, vice president sales; E. G. Dunford, treasurer; and T. L. Estrup, controller.

Heading the operating division at Benton is George Strunck, vice president operations, with E. T. Moroni as assistant vice president; and J. W. McDonald as vice president engineering; and Cecil Bailey as assistant chief engineer. Wayne Haynie is industrial engineer; J. E. McDonald is preparation manager, Hollis Pierce is electrical engineer, and Frank Eubanks is superintendent of maintenance; and R. Barminski is safety inspector.

The No. 21 mine staff includes Isham Jones, superintendent. Ford Bain, Dennis Frailey and Robert Littlefair, mine managers; R. Karroll, mine electrician; and Reuben Flatt, top foreman.

Coal Preparation

The product of joint effort by Old Ben and Roberts & Schaefer, the aim in designing and equipping the new No. 21 preparation plant was efficiency, operation with minimum labor, low maintenance and attractiveness. The buildings are covered with aluminum siding and U. S. Gypsum roofing, and the structural steel is coated with aluminum paint for flashing appearance.

The skips bringing the coal to the surface dump into a 20-ton bin provided with an air-operated gate to divert mine rock, when coal is not being hoisted, into a rock bin for truck disposal. The coal is fed from the bin by a reciprocating feeder over which is suspended a Memco magnet for removing tramp iron. This feeder discharges to a Hewitt-Robins 6x16-ft single-deck Gyrex screen for scalping off the plus 6 in lumps which pass to a 24x60-in Rockmaster crusher. The minus 6-in coal from the Gyrex screen combines with the crushed coal for processing in the preparation plant or diversion to a future storage pile.

An air operated gate also is installed in the chute from the reciprocating feeder to divert the coal from the Gyrex screen to a chute for direct rail loading of mine-run coal should the occasion demand.

Washing 6x¼

The 800-tph 6x0 raw-coal feed to the preparation plant is carried on a 48-in wide belt conveyor discharging to four double-deck Gyrex screens fed by a flight distributing conveyor. At the head end of the raw-coal belt conveyor is a Memco 42-in-wide in-line magnet for secondary removal of tramp iron for additional protection.

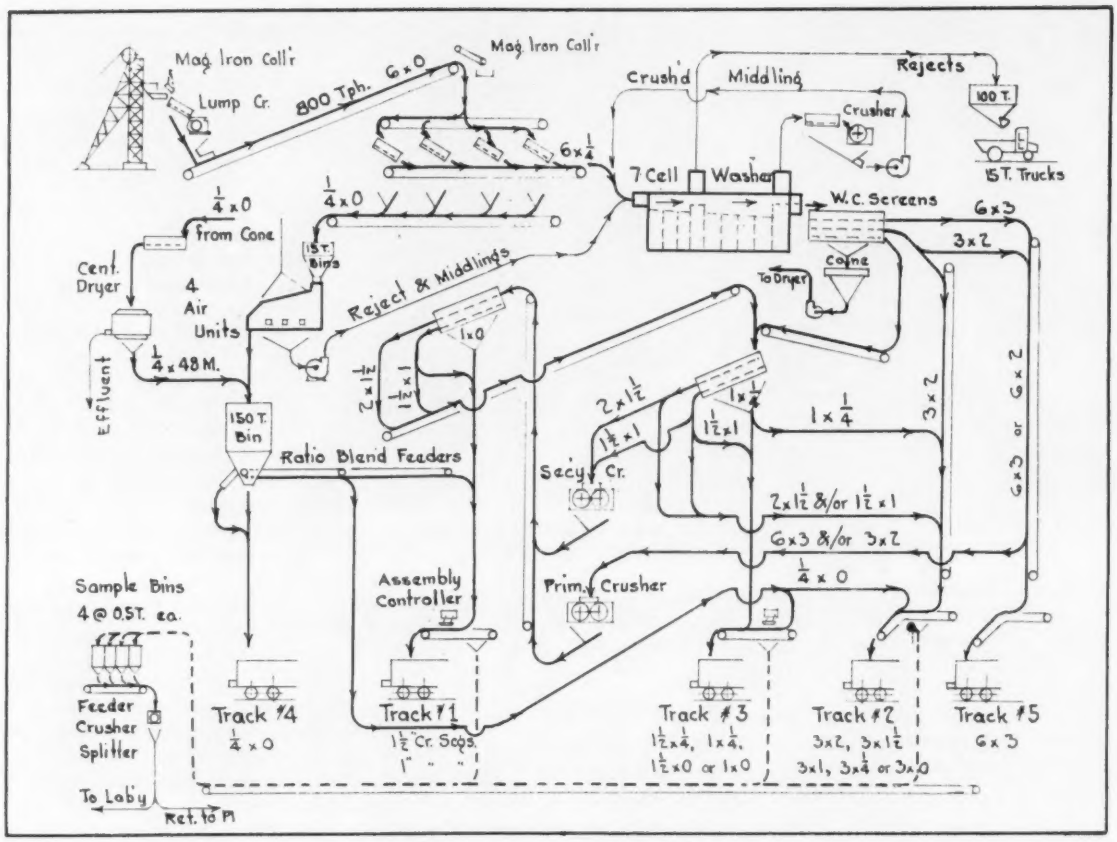
The sized 6x¼ product from the four raw-coal screens is discharged to a 42-in-wide jig-feed belt leading to a 96-in McNally Mogul washer. This jig with three primary cells and four secondary cells, discharges primary refuse to a 100-ton refuse bin and a secondary middlings product to a Hewitt-Robins 5x6-ft single-deck Vibrex screen for removal of the minus 1 in.

The minus 1 in may go to either a middlings sump or to the refuse bin. The plus 1-in middlings are crushed to 1 in by an American rolling ring crusher, and this crushed product is gathered in the middlings sump. An Allis-Chalmers 8x6-in CWG pump recirculates the crushed middlings back to the jig feed.

The clean coal from the jig is sluiced over two stationary dewatering screens, dressed with Bixby-Zimmer Tri-Rod screen with 3-mm openings, for delivery to two 6x16-ft triple-deck Eliptex dewatering screens. The top decks discharge 6x3; the second, 3x2; and the third, 2x¼.

The minus ¼-in combines with the through product from the stationary dewatering screens for delivery to a fine-coal settling cone. The fine-coal underflow from the settling cone is pumped by a Barrett-Haentjens 5-in TS pump to a 5x12-ft single-deck Eliptex dewaterizer for removal of the minus 28M.

The plus size reports to a Bird-Humboldt dryer for centrifugal drying and then to a 150-ton clean-coal bin via a 36-in belt. The Bird dryer may be by-passed for direct loading to the 36-in clean-coal belt should the necessity demand. The minus 28M is pumped to a settling pond together with the Bird effluent by a Barrett-Haentjens 4-in D-6BL pump. The clarified overflow from the fine-coal settling cone is used as jig make-up water delivered to destination by an Allis-Chalmers 14x12 CWE pump.



COAL FLOW in the Old Ben No. 21 plant.

Air Cleaning ¼x0

The minus ¼-in size from the four Gyrex raw coal screens is air-washed in four Roberts & Schaefer 8x12-ft Super Airflow cleaners. Auxiliary equipment used in this process includes Chicago Blower Corp. pressure, exhaust and recirculating fans, and Raymond 14-ft-diameter cyclone dust collectors with Crites tubes.

The clean coal from the four Super Airflows is gathered and conveyed to the 150-ton clean coal bin. The first and second draws from the Super Airflows report to refuse or may be recirculated to the jig feed. The third draws also are recirculated to the jig feed while the fourth draws are recirculated as dry middlings to the raw Super Airflow feed.

The dust from the cyclones may report either to clean coal or refuse. Should it be necessary the Super Airflow section may be by-passed completely or partially. Provision has also been made for future heat drying of the ¼x0 raw coal prior to Super Airflow processing.

Crushing and Screening

The 6x2 clean coal from the two triple-deck Eliptex screens may be diverted to a 24-in clean-coal belt for primary crushing in a 36x60 Gearmatic crusher. The 2x¾ clean coal from the Eliptex screens is conveyed by a flight conveyor to two double-deck 6x16-ft Vibrex screens. These screens are dressed for producing a 2x1 size which may be diverted to a 36x60 Gearmatic crusher for secondary crushing.

The combined primary and secondary crushed coal is conveyed by a flight conveyor to two double-deck 6x14-ft Vibrex screens dressed for a 1½-in top-deck and a 1-in bottom-deck separation. The total 1½x1 product may be recirculated for further refined crushing in the secondary crusher.

Loading

Clean coal may be loaded on five tracks. Track 1 is serviced by a loading flight conveyor for 1½x0 or 1x0. This loading conveyor contains an arrangement whereby a constant ratio of ¼x0 clean coal is drawn from the 150-ton clean coal bin by a measuring feeder conveyor driven by a Reeves Motodrive unit. Track 2 is serviced by a loading boom for 3x2, 3x1½, 3x1, 3x¼ or 3x0

Track 3 is serviced by a loading flight conveyor for 1½x¼, 1x¼, 1½x0 or 1x0. Apparatus identical with that on the No. 1 loading conveyor is employed to control the ratio of ¼x0 clean coal from the 150-ton clean coal bin. Track 4 is loaded only from the 150-ton ¼x0 clean-coal bin through the bottom or by means of a chute located on the bin side. Track 5 is serviced by a loading boom fed by a 24-in belt for a 6x3 size. All the clean-coal products being loaded are controlled by air-operated gates from a central location.

Sampling, Heating, Control

Clean-coal samples are gathered from points on Tracks 1, 2 and 3 by a

sample flight conveyor for delivery to four sample bins. These samples are taken from the bins by a 12-in-wide crusher feed belt conveyor for reduction in an American hammer mill. Excess crushed samples are elevated for delivery to the fine-coal settling cone.

An E. K. Campbell hot-air furnace, rated at 7,800,000 btu per hr, provides heat for the various locations in the plant. The furnace is stoker fired.

The plant is powered by 92 motors, primarily Westinghouse, totaling 1,730 hp. The 440-V, 60-cycle, 3-phase power is obtained from two 100-kva 2,300/440-V transformer banks on the roof of the preparation plant adjacent to the control room. The starters for all motors are installed in four control centers located in the pressurized control room.

The plant is operated from two positions, one on the jig floor and the second in a cab over the loading tracks. All plant operations except the loading gates and sampling are controlled from the jig-operator's panel.

Interlocking has been provided to assure starting in proper order and automatic shutdown of all units following a motor which has stopped because of overload or power failure.

Each of the Super Airflow cleaners and related blowers are controlled automatically by low-level Bindicators in respective surge bins. This permits the operation of each Air Flow in the most efficient manner by maintaining its bed of coal.

The loader operator controls the sampling on Tracks 1, 2 and 3. This he does by depressing the pushbutton for the desired track, which sets up the gates and sampling gate so that the sample is taken and dispatched to the proper sample bin. After a determined period of time, certain gates are closed in order to eliminate contamination of the coal samples.

Air-operated gates over each track are controlled electrically by solenoid valves which enable the loader to select remotely the proper loading point on each track. On Tracks 1, 2 and 3 there are three loading points, as follows: Normal position, car-changing position, and diesel-locomotive by-pass position. The loader can select any one of these positions on each track by the depression of one pushbutton which shifts all the gates required for loading at the selected car position. Each track-loading position is indicated on the loader's panel by lights connected by a red tape which shows the flow of coal.

The lighting of the plant is by open-type 150-W RLM incandescent fixtures. The lighting supply is 4-wire 208Y 150-V, 3-phase, 60-cycle. Most of the lighting in the plant can be turned on by a pushbutton located at each entrance to the building. This pushbutton controls contactors in the various lighting panels distributed around the plant.

The majority of the lighting fixtures are suspended by rubber cord with a twist-lock plug and receptacle for easy removal for repairs and cleaning.

Rigid galvanized conduit and stranded wire was used throughout for power and light wiring. Approximately 33,000 ft of conduit of various sizes and 212,000 ft of wire from No. 14 to 500,000 circ mils was used.

The main preparation plant is five stories in height, and is equipped with an elevator for handling parts and materials. Construction involved 604 tons of structural steel; 53,000 sq yd of aluminum covering; 553 cu yd of concrete; 305 aluminum sash; and 2,300 panes of glass.

In addition to the McNally Mogul washer, four Super Airflow pneumatic cleaners, Bird-Humboldt dryer, motors, etc., major equipment units include the following:

- 800-tph reciprocating feeder.
- 5 crushers—up to 240 tph each.
- 13 vibrating screens, 2,270 sq ft of decking.
- 7 belt conveyors, 1,260 ft of belting.
- 16 scraper conveyors, 4,100 ft of chain.
- 3 bucket elevators, 350 ft of chain.
- 12 blowers, 168,000 cfm.
- 5 pumps, 7,300 gpm.

Refuse is handled to the disposal area by a 15-ton rear-dump Euclid. The small quantity of bleed water from the plant goes to a settling pond, with clear overflow from this pond going into the main plant reservoir.

Coal is weighed on an automatic scale which prints the data on a tape in the mine office, equipped with a television unit for car name and number scanning.

Old Ben Through the Years . . .

Beginning in 1874, Old Ben's predecessor, the Wilmington Star Mining Co., headed by M. D. Buchanan, father of D. W. Buchanan Sr., present board chairman, developed seven mines in the Wilmington coal field of Grundy County, in northern Illinois. In 1909, recognizing its growing importance, Old Ben entered the Franklin County field of Illinois, acquiring approximately 2,000 acres near W. Frankfort and developing Mine No. 8.

Over the years there have been 14 Old Ben mines in southern Illinois. At present, three are in operation: Nos. 9, 14 and 21, with an ultimate combined capacity of 25,000 tons, of which No. 21 will contribute 15,000. Approximately 200 million tons of Franklin County coal have been produced by Old Ben since 1910, when the first car left No. 8.

It is estimated that Old Ben's southern Illinois reserves aggregate more than 320,000,000 tons of recoverable coal, or enough to support the present production rate for 80 to 100 yr.

Old Ben also owns and operates one mine in West Virginia, one in Virginia and a briquetting plant in West Virginia, and is exclusive sales agent for five other Eastern mines.

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First to develop and patent a practical mechanical rock duster, the work of the late John E. Jones, Old Ben safety director. After patenting, rights to use the principles without restriction were donated to the public.

First in Illinois to make electric cap lamps compulsory.

First in the U. S. to dry clean bituminous coal mechanically.

First in the use of color-marking (Old Ben Greenmarks) to continuously identify bituminous coal.

First to briquet Illinois fine coal.

First in Illinois to clean coal in a chemical heavy medium (calcium chloride).

First to employ air-shooting on a commercial basis.

First in Illinois coal shipped via Great Lakes vessel.

First in southern Illinois to adopt radio communication between underground haulage locomotives.



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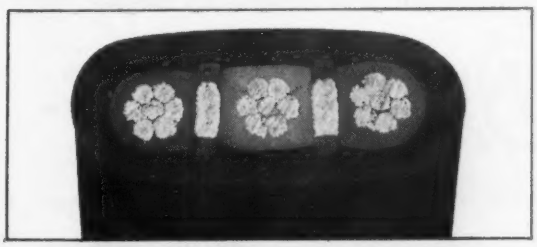
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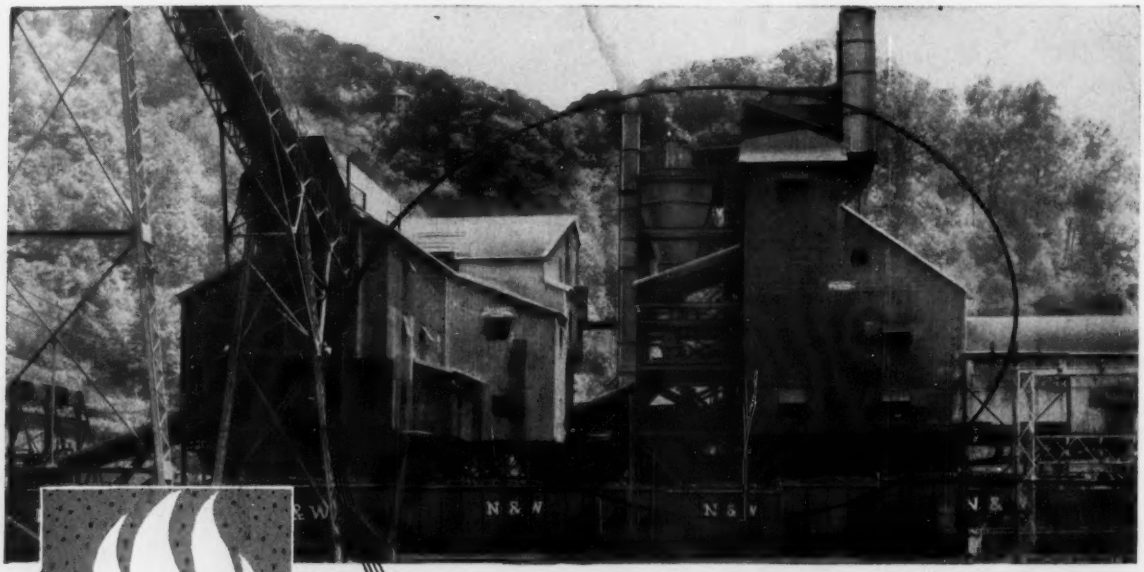
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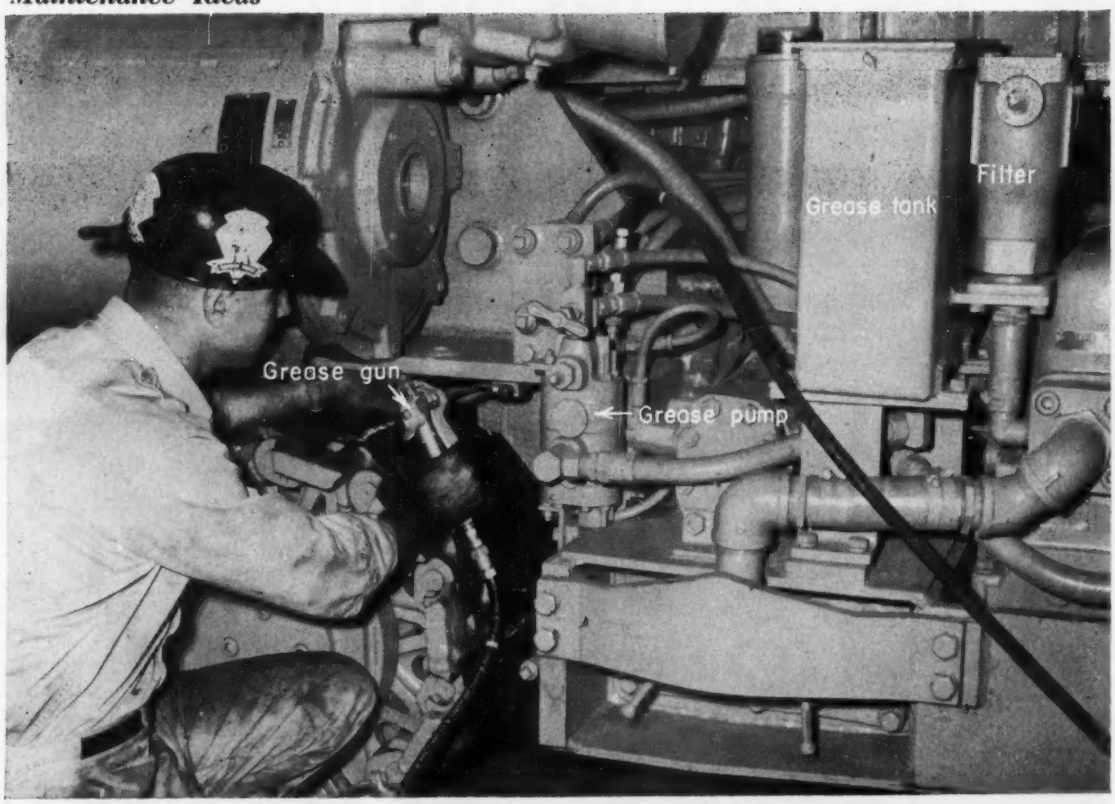


FIG. 1—MAINTENANCE AUXILIARIES include integral lubricating pump and gun, hydraulic-oil filter and remote check-and-fill ports for inaccessible transmissions. The hydraulic-system filter is equipped with a visual indicator.

How to Improve Continuous-Miner Maintenance

Problem: A continuous miner, viewed as a unit, is a complex machine for a mechanic to understand or service.

Solution: In training and practice stress the maintenance and servicing of sub-assemblies and power-transmission systems and provide auxiliary aids.

By **Joseph Mason,** Maintenance Superintendent, Mountaineer Coal Co., Fairmont, W. Va.

THE CONTINUOUS MINER of today is a complex machine, but well-designed and precision-built with a potential capacity of 200 to 300 tph. The potential capacity is such that one minute delay means from 3 to 7 tons of coal lost, so it is most important to keep the continuous miner operating at its rated capacity as much of the time as possible. Undoubtedly, one of the greatest limitations on continuous production from the miner is machine maintenance.

The basic problem in the maintenance of the miner centers around the complexity of the machine. It is simply too complex for our jack-of-all-trades mechanic. The transition from conventional to continuous mining has taken place so rapidly that the mine mechanic has been unable

From a paper presented by Mr. Mason at the Spring Meeting of West Virginia Coal Mining Institute, Morgantown, W. Va., Apr. 22-23, 1960.

to keep pace. When there is a machine failure, the maintenance man has limited alternatives–he usually employs either the trial and error or "play it by ear" method of repair, but this represents an expensive proposition.

There is a shortage of men skilled enough in the class of work required in the maintenance of these complex machines. So, what's the answer? Better trained maintenance–better maintenance instruction–better field service. These are all good corrective measures, but the real cure is to provide for the man down at the "do it" level.

This article deals with a program of preventive maintenance to care for AC or DC continuous miners operating three shifts per day, five days per week. It is not intended to delve into the theory of preventive maintenance; volumes have been written on the subject. Specifically, it tells how a program of preventive maintenance is carried out with special emphasis placed on providing for the man at the "do it" level.

Study the Components

Since the miner, when viewed as a whole, is admittedly too complex for the jack-of-all-trades mechanic, it is broken down into its component parts and thus becomes easy to understand. The continuous miner is simply a combination of mechanical, electrical and hydraulic components. In organizing and executing the maintenance program, each of these three components is treated as a system. Once the program has been broken down into this simple form, definite policies and procedures can be established to ensure effective maintenance. The selection, training and placement of mechanics and technicians become more effective.

To further assist the maintenance man to do his job better, faster and easier, adequate service facilities are provided. Adequate service facilities are those required to promote the six basic maintenance functions of checking, servicing, adjusting, repairing, replacing and trouble-shooting. Visual indicators, test facilities and other devices are installed as an integral part of the machine to provide for fast and efficient applications of lubricants, to provide instrument-panel type of daily inspection with minimum interruption in production, and to replace the expensive trial-and-error method of trouble-shooting.



FIG. 2–SURFACE THERMOMETER and stethoscope are useful instruments.

Mechanical System

Maintenance of the mechanical system includes the inspection and care of clutches, gear sets, bearings and structural members. Worn and overheating bearings, leaking oil seals, worn gears and bushings are replaced before failure. Nuts and bolts are kept tight and, above all, the machine is properly lubricated.

Proper attention to lubrication cannot be overemphasized. Lubrication is by far the greatest single factor in the maintenance of the miner, in reducing downtime and lowering maintenance cost. A sound lubricating program can be reduced to two parts. One is to establish a lubricating schedule with a definite check list; the second is getting the job done, but getting the job done in minimum time and at minimum cost.

A fast and efficient scheme for applying lubricants to a continuous miner is by use of a power gun. In this method the entire package, complete with a grease motor-pump and storage tank occupying relatively little space, is installed as an integral part of the machine and powered from the machine's hydraulic system (Fig. 1). With lubrication equipment of this type, the mine mechanic can service the most complicated miner in the same fast and easy manner that a service-station attendant services your car.

In addition to the gun application of grease to bearings and other moving parts, gear cases, gear reducers and transmissions also require daily care. To facilitate servicing and inspection of this phase of the lubrication program, all inaccessible gear cases are piped out to convenient locations and clearly labeled.

Inspection is a daily function integrated as a day-to-day part of the operation. The person directly responsible for the daily inspection is the section mechanic. He combines a portion of his inspection, principally the visual checks of nuts, bolts and weldments, with lubrication. During the mining operation he continues his check for temperature of gear cases and bearings.

Since noise is an indicator of ball bearing trouble, noise testing is a means of quickly checking the running qualities of a bearing. A stethoscope made for this purpose is provided (Fig. 2). A popular method of making a quick casual check of bearing temperature is to feel the housing cautiously with one hand. If the bearing is comfortably warm, the decision is that the bearing is not in any danger from overheating. However, as the temperature rises, this method does not give an accurate picture. A bearing service housing begins to feel hot at about 125 F, and beyond that a thermometer should be pressed into service. There are various forms of thermometers and methods that can be used, some more expensive and more accurate than others, but a very popular style is the surface temperature thermometer (Fig. 2). A small magnet holds the thermometer on the surface to be tested while the machine is operating. In addition to bearings, temperatures of gear cases, speed reducers and other units are checked.

To retard and reduce bit holder maintenance several arrangements of various types of blocks have been tried. The amount of maintenance work required is directly proportional to bit cost. Shock loads encountered by the bits are transmitted back through shafts, gears and bearings, yet the miner must be prepared to at-

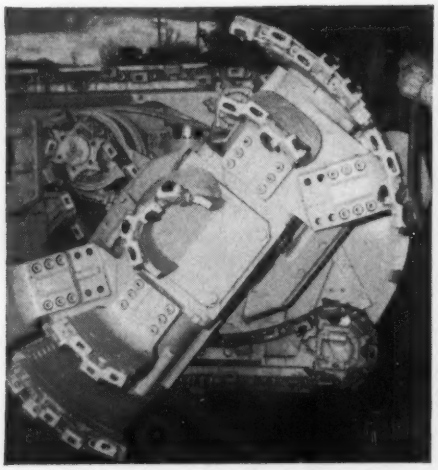


FIG. 3—RAP LOCK bit blocks require no set screws. Special tool sets bits.

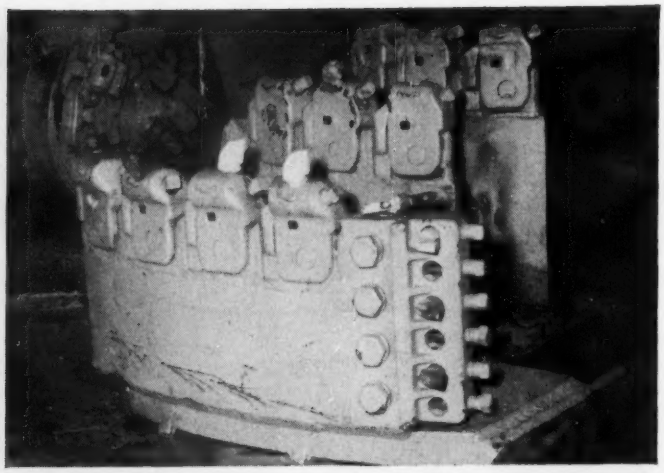


FIG. 4—DETACHABLE bit block is held in place on tool holder by pin. No welding is required.

tack a moderate amount of hard material other than coal, and it must do this without increased cutting and maintenance cost. There are several basic requirements that must be considered in a cutting element to meet the demand for maximum running time and lowet maintenance cost. Probably the most important is the cutting bit. The emphasis is placed on bigger and tougher shanks, fewer and faster bit changes. Bit blocks requiring no set screws have reduced the time for changing bits. The rap lock (Fig. 3) and the rectangular taper shank are examples of the no-set-screw type block used successfully in our program. Another important development in bit blocks for the continuous borer is the pin-on type or detachable bit block. This block is pinned on the rotor arm cutters in the same manner as the blocks on a conventional cutting chain (Fig. 4). These blocks do not require welding for their support. They are quickly and easily replaced or installed with a hammer and punch. Thus less time to replace bit blocks, which is excessive with the weld-on type block, means more time for mining coal.

Hydraulic System

Widespread use of hydraulics in the continuous miner presents new maintenance problems and, as a result, downtime from hydraulic failures is becoming the number one maintenance problem. In a hydraulic system there are a number of factors contributing to faulty operation and ultimate failure. The main causes of trouble are dirt in the fluid, air in the system, and cavitation of the pump. Most of the hydraulic problems can be solved with application of filters.



FIG. 5—SIGHT-FLOW INDICATOR for circuits provides functional check.

Effective filtering is one of the biggest factors in successful hydraulic operation. They are the traffic policemen of modern piping, guarding against dirt and foreign matter which are so detrimental to the performance and life of hydraulic equipment. A successful filtering program must include a periodic cleaning schedule. This is where most hydraulic maintenance programs fail. Much hydraulic servicing is caused by clogged strainers. This causes pump cavitation, resulting in reduced pump delivery and slow machine cycle, and sometimes complete failure. Too often the strainers and filters are not cleaned.

Therefore, a simple reliable means of detecting when a filter needs replacement is obviously essential. Filters must have indicators. The Rosaen filter is an effective filter used both for suction and in line that includes a self-contained indicator with bypass protection. The indicator shows the condition of the filter, indicating whether it is clean, needs cleaning, or is bypassing oil.

For the non-indicating type filter, a visual flow indicator is connected across the filter, with bypass protection included, which will clearly indicate when the filter needs replacing. This is an important application of the flow indicator (Figs. 5 and 6) in providing the maintenance man with an expedient means to carry out one phase of hydraulic system inspection.

Care of the system starts with filling the tank because it is here, through the breather filling inlet, where much of the dirt enters the reservoir. When adding make-up oil, special precautions are taken to ensure that clean oil enters the system. In our program two methods are used to add make-up oil. In one group of miners, a small hand pump is used with a good filter, the oil being pumped out of a can through the filter directly to tank (Fig. 6). In another group of miners, oil is pumped into the reservoir through a filter by means of an electric-driven pump. This pump is the same pump that powers the machine hydraulic cylinders. In addition to meeting the requirements of clean-

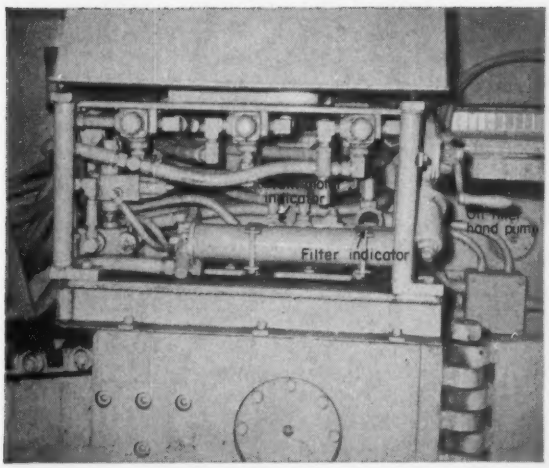


FIG. 6—FLOW INDICATORS are installed in tram motor circuit and filter bypass line. Hand pump injects oil.

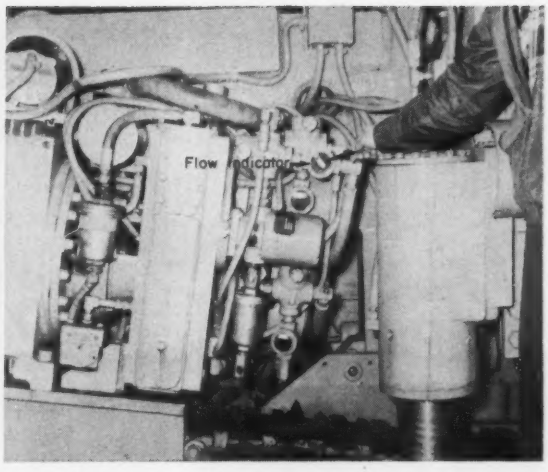


FIG. 7—FLOW INDICATORS in relief-and sequence-valve circuits show how these components are operating.

liness, this scheme is fast and easy and actually makes it possible to add oil while the machine is producing.

In addition to more minutes of operating time, there are other advantages in a fast, easy filling scheme. Because of the simplicity and speed, the tank will always be full, thus minimizing the troubles from pump cavitation, high temperature, sluggish hydraulic operation and dirt pick-up from the bottom of a low level tank.

Continuing our preventive action, relief valves are locked at their proper setting and are periodically checked with a conventional pressure gage. Surge pressure relief valves are installed at the source of shock waves to greatly minimize damage. These are installed on cylinders vulnerable to damage from high surge pressures and have proved very successful.

But in spite of all the preventive measures, trouble will occur, and when trouble occurs the object is to locate it in the shortest possible time. Of all the hydraulic troubles, one of the most difficult to locate is air. Air entrained in hydraulic fluid causes poor feed, cavitation and suction failure. Air trapped in cylinders causes spongy action. Bleeder valves installed on cylinders will release trapped air. Bleeder valves installed in pump discharge line ahead of any other component allow the pump to purge itself of air immediately upon starting of the electric motor.

As a trouble-shooting device the flow indicator asserts itself as a valuable aid for both the skilled and unskilled hydraulic maintenance man. These are installed in discharge lines of relief valves, sequence valves, and drain lines of piston-type pumps and motors so that the mechanic can tell at a glance which component in the system is causing the malfunction (Fig. 6 and 7).

For example, in the piston motor, flow through the indicator informs the mechanic as to the condition of the unit and clearly indicates when it is time to replace the unit. No trial and error here—no shutdown for time consuming checks. Inspection and trouble-shooting is done while the machine is producing. The flow indicators installed in relief valve tank lines aid the mechanic to analyze other troubles in the system.

A portable hydraulic tester is necessary equipment for trouble-shooting a hydraulic circuit.

Electrical System

Maintenance of AC equipment is much simpler than maintenance of DC equipment. But, regardless of the power system, most of the downtime from electrical trouble is directly attributable to trailing cable failure. The major causes of cable failure are mechanical damage and excessive tension. Mechanical damage is primarily from other section equipment. Proper care and handling will minimize trouble from this source. To reduce excessive tension, the trailing cable is pulled over rollers which are installed in rib holes on about 12-ft centers. The holes are drilled in the rib with a conventional coal drill powered from a miner hydraulic system. These are drilled as the miner advances with no interruption to production. The cable is pulled over rollers from the miner where it is clamped with a Kellems grip (Fig. 8).

The Kellems grip is a very good means for clamping cable to the machine because it distributes the load radially and conforms naturally to the exact shape of the cable. Since the Kellems grips do not choke the cable at one point, unit stress on the surface of the cable is at a minimum.

To prevent serious damage to cable, power or control-circuit wiring, motor windings and other electrical components from ground faults, a ground fault protective unit is installed as part of the power source. In the AC system, in addition to ground fault protection, push button testing of the safety ground trip mechanism in the automatic breaker is included on the miner. This test made at the machine provides a convenient check on the continuity of ground wire in the trailing cable to power source as well as a check on the ground trip circuit at the power source.

However, when a cable fails, quick restoration of service is required. First the fault must be located. Searching for and locating a hidden fault can be most difficult and time consuming, particularly in the AC system. Electrical fault finders are available for locating cable faults; however, our ex-

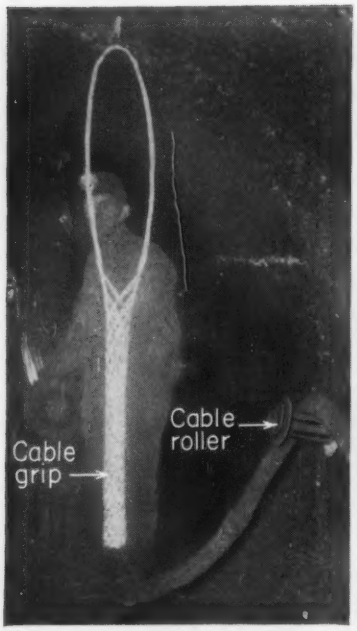


FIG. 8—TENSION GRIP and cable roller minimize damage to cables.

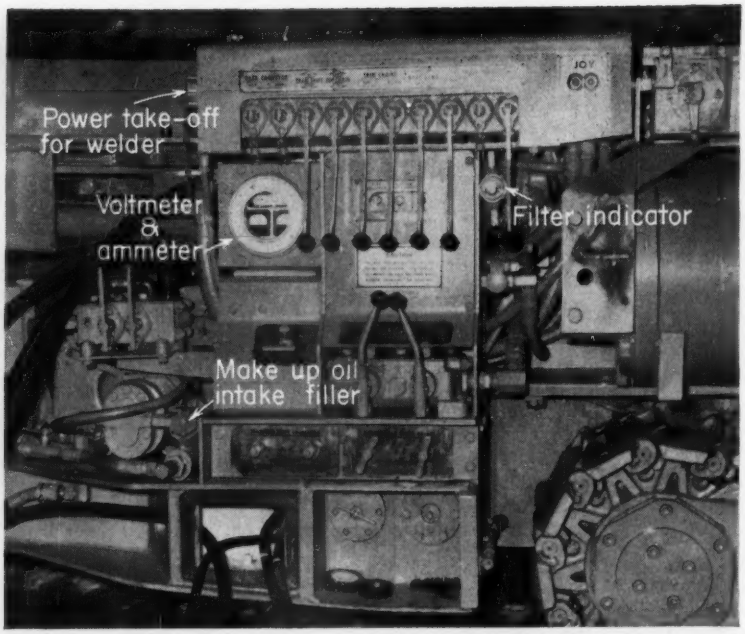


FIG. 9—METERS are a source of help in troubleshooting by providing basic readings of voltage and current in machine circuits.

perience with them has not been too successful. The method described below has proved to be best for us.

Regardless of the method used to locate the fault, the fault must be repaired and service restored. However, on-the-spot cable repair at best is temporary and will only lead to recurring troubles. To avoid temporary splicing and to eliminate costly downtime from cable failure, spare cable stored on the section and sectionalized in lengths of 100, 200 or 300 ft can be quickly substituted for one that has failed. The damaged cable is then repaired at a cable repair shop. To employ this method of handling cable failure, of course, requires that the trailing cable be installed in convenient lengths with individual sections joined by permissible connectors.

Proper voltage and cable care are only part of the program of electrical maintenance. Basic readings of current and voltage are necessary to provide electrical information as it relates to performance and maintenance of the miner. Ammeters and voltmeters, mounted at the operator's platform, are connected in the electrical circuit to indicate current and voltage (Fig. 9). These instruments not only provide basic information in troubleshooting, but are also very valuable to the mechanic in pinpointing trouble in the electrical system, such as low voltage, unbalanced loads, improper clutch settings, and open circuits. In most instances, basic facts derived from these meters pinpoint trouble without the need to investigate a controller, motor or junction box. For example, with two identical motors driving through a common gear train and the meter indicating that one motor is taking all or most of the load, it is likely that the clutch on the unloaded motor is slipping.

Daily inspection of the electrical system is made during the mining operation by observing the ammeter and voltmeter, checking temperature of motors, and trailing cable and connectors. Push button check of the ground protection equipment is made at any convenient time during the shift. A routine inspection schedule of the electrical equipment is designed along the same lines as that set up for other mining equipment. The inspection schedule is determined on the basis of severity of service, type of miner AC or DC, and the cost evaluation of the components of the electrical system.

Daily Repair

But even with the best routine maintenance that can be practiced, breakdowns and production interruptions cannot be completely eliminated. The maintenance program must provide for such breakdowns. The unit changeout or package assembly system offers the best means for effecting both emergency and scheduled repairs at the face. This method eliminates time consuming repairs because the replacement of an entire unit can be made in much less time than on-the-job repairs on the unit. In almost every instance of failure, a complete assembly, having been correctly assembled well in advance by experts, can be installed in less time than is required to disassemble, investigate and reassemble. Furthermore, the installation of a given unit does not require any special skill, so a specialist and close supervision are not essential.

Not only time but supplies on the section can be kept to a minimum in the unitized method of repair. The only supplies required on the job are the smaller, more frequently used items such as hydraulic hoses, cutting and conveyor chain parts, nuts, bolts, and other parts required to make small running repairs. The spare units, stored in surface or underground shops, are dispatched to the section as needed. These spares are also used in the overhaul schedule. The initial cost to get this program underway is high, but frequency of failures and

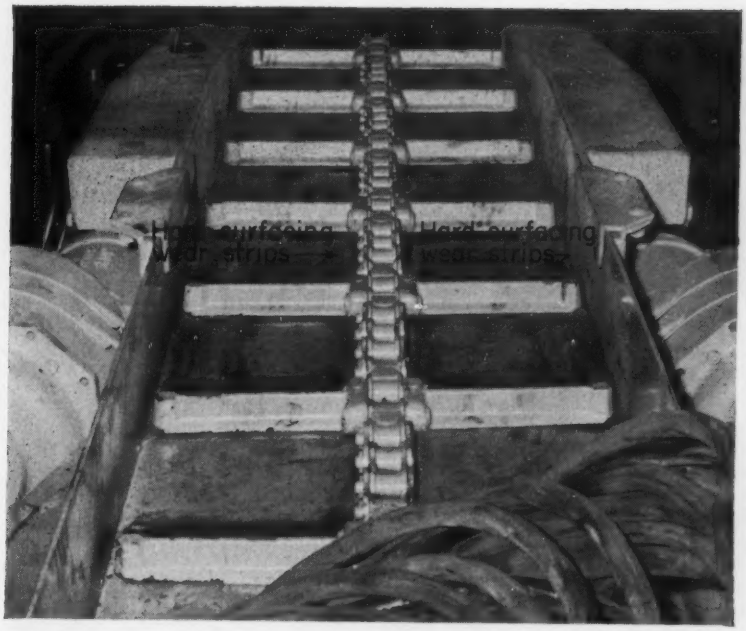


FIG. 10–CONVEYOR BOTTOMS are lined with abrasion-resistant steel to increase life of both conveyor and conveyor chain.

downtime, not dollars, will determine what units are needed and where they are to be stored.

The unit changeout schedule must be revised from time to time in order to get the maximum yield from these units. If changeouts are scheduled too far apart, the units would break down during the production shift or be driven to destruction.

Regardless of the system of repair that is employed, parts on continuous miners for the most part are inaccessible, bulky, and working quarters are crowded. For example, a 100-hp, AC motor weighs 2400 lb; a Goodman 250-hp motor, 4,500 lb; Twin-Borer transmission, 6,000 lb; Joy borer conveyor, 6,000 lb. These are typical of the units that must be handled underground. How are these to be handled?

One company equipped a shuttle car with a long boom to do lifting jobs of heavy machine units. Universal cutting machines, when available, have been used on the section for hoisting purposes. Baker-Raulang wood timber setters, although limited as to lifting capacity, serve as excellent cranes. Whether it is the unit system or on-the-job method of repair, a mobile repair vehicle equipped with a boom to handle the lifting of the bulky, inaccessible parts is necessary equipment to effect fast and easy repair and quick restoration of service after a breakdown. We have designed a mobile repair vehicle not yet in service that is self-propelled with a self-contained vise, grinder, oxygen-acetylene equipment, and power takeoff for power tools. This can be dispatched to any work area for a scheduled repair job or to handle most emergency breakdowns.

A portable welding machine powered from the miner is used for the welding jobs at the face. The welding machine is mounted on rubber tires and can be easily moved to any location on the section for all of the welding needs. This arrangement is highly desirable where it is impractical to move a miner back to a location where it can be reached from a welding machine.

Overhaul

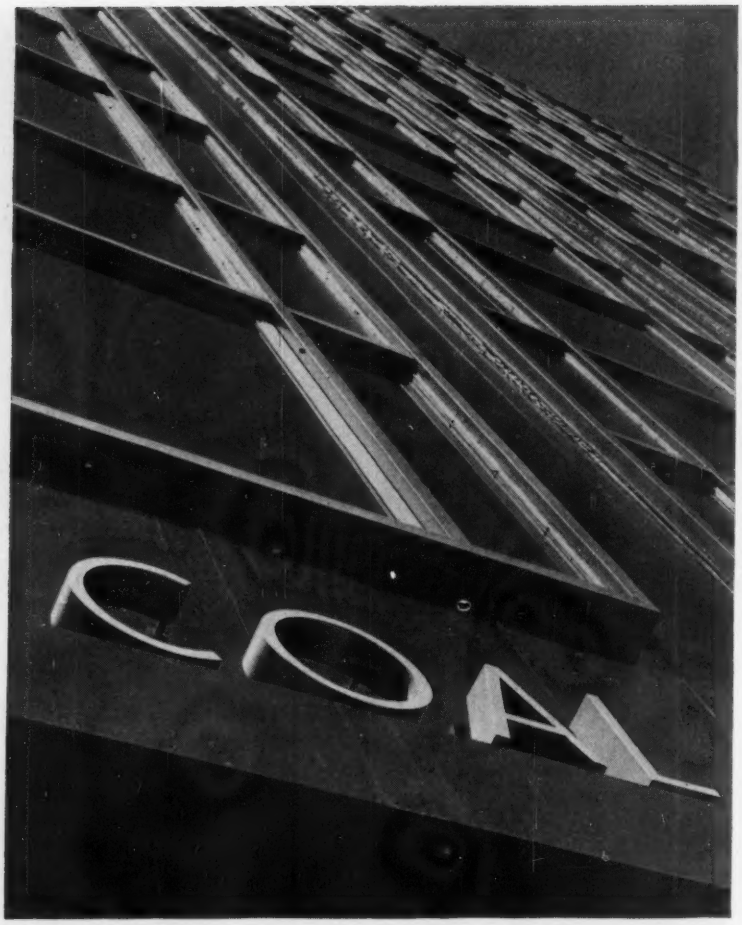
Since machines depreciate even under the best of care, an overhaul plan must be included in the maintenance program. Complete overhaul means complete dismantling and rebuilding on the basis of time or tonnage. Tonnage is generally used as the basis for determining overhauls, but regardless of the standards used to determine such overhaul, the machine must be overhauled as necessary.

For a complete overhaul, the machine must be moved to an underground or surface shop where facilities are available consisting of an electrical, welding and machine shop and adequate hoisting equipment. Here electric motors and hydraulic equipment are removed, tested and reconditioned. Mechanical components are removed and rebuilt. Conveyor bottoms are rebuilt with special hard metal to resist abrasion and increase service life. Fig. 10 shows the application of hard metal strips to a conveyor bottom. Wear points are hard-surfaced to resist wear and increase life. A central repair shop, where a crew of trained personnel with special skills can be assigned to this work, is an ideal arrangement for the rebuild program.

A second method of overhaul, although not as thorough as the first, is desirable where transportation of miner from face to shop is a problem, or when a large number of miners in service makes it difficult to schedule machine rebuilds without jams resulting from two or three miners coming in for overhaul at the same time. In this method, the miner is not taken out of service, but is rebuilt on the section over a long interval of time. Gear cases, speed reducers, transmissions, conveyors, hydraulic and electrical equipment are installed as packaged unit. These units, having been assembled well in advance, are the spare assemblies originally purchased to carry out the daily repair program.

The primary objective in a continuous miner maintenance program is to get maximum yield through maximum running time. The success or failure in maintenance will be a measure of the success or failure of the operation.

To be successful the maintenance program must have management backing. The time has come when maintenance is no longer something of a stepchild of the industry. It must be put in its rightful place, on an equal level with production. Unless we are prepared to recognize the problem of maintenance, the continuous mining machine will fail to accomplish its purpose. The program outlined here has helped us reduce cost in our operations in which 75% of our total output comes from continuous miners, and I'm sure it will help others.



PROGRESS SYMBOL: New "Coal Building" stretches majestically upwards to Washington skies. Building was dedicated June 9 by Int. Dept. Secty. Fred Seaton.



NEW NCA Board Chairman, Herbert E. Jones is board chairman, Amherst Coal, Amherst Fuel, Amherst Barge Cos.

Teamwork is recurring theme as reorganized National Coal Association discusses industry progress, problems and prospects.

NCA Convention Report

REPORTS on reorganization progress and dedication of the new "Coal Building" featured proceedings of the 43rd Annual Convention of the National Coal Association held June 8-9 at the Mayflower Hotel, Wash., D. C.

Keynoting reorganization progress, NCA President Stephen F. Dunn reported, "We are moving with an accelerated pace and, if I may so so, 'you ain't seen nothing yet.' Coal's smashing victories are just beginning."

Keynoting dedication ceremonies, the Hon. Fred A. Seaton, Secretary of the Interior, cited the industry for "the manner in which it has organized itself for positive action to overcome its problems. . . . By consolidating and streamlining the activities of your national association, the leaders of your industry have given substantial evidence that they are ready to meet the challenge of the future."

To head up its Board of Directors as chairman, NCA elected Herbert E. Jones Sr., chairman of the boards, Amherst Coal Co., Amherst Fuel Co. and Amherst Barge Co. Mr. Jones succeeds F. Stillman Elfred, chairman of the board, Peabody Coal Co.

Other newly elected NCA officials were as follows:

Vice chairman—George E. Enos, president, Enos Coal Mining Co., succeeding R. L. Ireland, chairman, executive committee, Consolidation Coal Co.

Treasurer—David L. Francis, president, Princess Coals, Inc., succeeding Mr. Enos.

G. A. Shoemaker, president, Consolidation Coal Co., was elected to fill the board vacancy left by the death of A. R. Matthews, formerly Consol president. All other board members were reelected or had continuing terms to serve.

INDUSTRY MEETING—
A Special *Coal Age* Staff-Written Report

In other actions, the board (1) adopted a resolution in memory of Mr. Matthews citing his "execptional leadership abilities" and outstanding contributions to "the enduring benefit of the entire industry," and (2) approved BCR plans to build a $875,000 central coal research laboratory in the Pittsburgh, Pa. area.

At its annual meeting before the main convention proceedings, BCR, now an NCA affiliate, elected NCA President Dunn as new BCR president, succeeding Dr. A. A. Potter, who is retiring. Dr. H. J. Rose, retiring vice president and consultant, received BCR's annual award for outstanding leadership on behalf of industry-sponsored research.

BCR also elected five new members and re-elected four members to its 15-man Board of Directors. Terms of six other members run until 1961. The new members are: B. R. Gebhart, vice president, Freeman Coal Mining Corp.; Harry LaViers, president, South East Coal Co.; E. B. Leisenring Jr., president, Stonega Coke & Coal Co.; H. C. Livingston, presi-

Business Session Speakers . . .



GOVT. RELATIONS. Tom Pickett, vice president



MARKETING W. W. Bayfield, vice president





LAW R. Hall, general counsel (left), R. L. Hirshberg, associate counsel.



FISCAL MGT., T. Howarth, Secty.



ECON.&TRANSP. M. Robinson, dir.



RESEARCH, James Garvey, dir.



PUBLIC REL., Rex Chaney, dir.

dent, Truax-Traer Coal Co.; and S. F. Sherwood, Stonefort Coal Mining Co.

In NCA's business session, Thomas Howarth, secretary and assistant treasurer, explained problems and duties of the association's Dept. of Administrative and Fiscal Management. Following are abstracts of talks presented by NCA staff members on aims, activities and accomplishments of other reorganized departments.

Government Relations

Tom Pickett, vice president—The Dept. of Government Relations is charged with the responsibility for all contacts with the Congress and Federal Government departments, agencies and commissions. Activities on state matters are restricted to furnishing appropriate information to member companies for their own use. In addition, it is the dept.'s responsibility to recommend new policies or changes in existing policies.

Time does not permit a detailed description of the multitude of functions required to discharge our legislative obligations. The following, however, may serve to illustrate demands on the dept.:

1. More than 18,000 bills and resolutions have been introduced in the present Congress. In excess of 2,000 of these are of direct and indirect interest to the coal industry and have been indexed and filed for ready reference at the appropriate time.

2. At the present time, legislation on more than a dozen subjects embracing several times that many bills is under active consideration in either the House or the Senate. We are watching them daily.

Illustrative of the type of legislation we follow carefully and report on regularly are bills falling the following categories: antitrust, atomic energy, coal research, foreign trade, labor, land- and water-use, mine safety, mines and mining, national fuels policy, natural gas, air- and water-pollution, public lands, public power, taxation and transportation.

We support aggressively many proposals which benefit the industry. Equally important is the effective opposition to a multitude of proposals that would be harmful if enacted—an activity that is sometimes referred to as the administration of preventive medicine.

Besides screening and analysis of bills affecting coal, other duties include preparing bills for introduction and amendments to those under consideration, testifying and arranging for the testimony of industry witnesses, assisting in preparation of statements, furnishing information to members of Congress, their offices and committee staffs on coal industry matters.

The Government Relations Dept. of NCA, as such, is less than 6 mo old. However, its activities have been conducted aggressively for the past 7 yr. Achievements have included fairer legislative breatment for coal in the field of atomic energy, oil imports, natural gas, public power and taxation. The dept.'s staff pledges even more aggressive activity and intensified effort to secure industry cooperation in the field to achieve even greater results.

Marketing

W. W. Bayfield, vice president—The Marketing Dept. is composed of the Air Pollution Div., under the direction of Mr. Harry Ballman (formerly, manager, field operations, BCI); the Manpower Development Div., under Dr. Paul Brown (formerly in-charge-of sales training for American Coal Sales); and the BCI Market Promotion Div. under the direction of Carroll Hardy. Mr. Coryell, who formerly headed NCA's Engineering Dept., replaced Mr. Ballman as manager, field operations, BCI. In addition, we supervise the operation of Bituminous Coal Equipment., Inc. (formerly Automatic Solid Fuels Equipment) which could not be integrated for legal reasons.

As of May 1, Harry Ballman, with his two field engineers, has worked with air-pollution-control officials in 17 different cities extending from Windsor, Ont. to Danville, Va. and from Trenton, N.J. to Chicago, Ill. In each community, they dealt with coal-fired plants causing smoke problems. In each case, engineering reports were made specifically recommending corrective action preventing conversions to other fuels. Over 200,000 tons of on-track business and approximately 30,000 tons of off-track business were involved. Projects already scheduled for action in the second quarter will involve greater tonnage than in the first quarter. In fact, the demand for services far exceeds the time available to this small staff. However, we will get around to every project as rapidly as possible.

Our Manpower Development Div. conducted a 1-wk sales seminar for BCI's field men to sharpen their promotional and sales know-how to match their unquestioned technical ability. In this program, we were aided by several industry sales officials including Messrs. Kepler, of Consolidation; Jewell, of Peabody; Clovis, of Traux-Traer; and Kelsey, of Island Creek. In May, we conducted the first of a series of 2-day Advanced Management Workshops for NCA marketing executives and at least two more will be offered this fall. This month our 2-wk course in combustion and coal utilization for industrial salesmen will be conducted at Ohio State University. We are also planning several 3-day conferences on sales methods later in the year for your territory representatives.

All of these developmental programs are self-sustaining. In fact., where we have full attendance, the association realizes a small profit over and above the expenses of our personnel who participate in the programs. No other association in this country offers its members as complete a selection of manpower training developmental programs. These sessions

have received the highest compliments from professionals in the field and from companies in other industries. We believe this service is particularly valuable since few of our members are large enough to warrant the maintenance of training directors or formal training programs.

Turning now to BCI, I have been shocked to learn that many of our members do not have a clear understanding of this Div.'s objectives and, more particularly, the functions of its field representatives. We have two goals: (1) to promote and sell the use of coal to industrial and commercial accounts that are not now our customers (accounts include those planning new construction and those presently burning another fuel); (2) to assist member companies when a plant is threatening to convert from coal, but only at your request and under certain conditions. Descriptions of policies and procedures have been sent to all members.

Field representatives cover all but a very small geographical section of the U.S. Each man must contact, at regular intervals, every consulting engineer in his territory; to call as often as possible on a selective list of architects; to assist these professionals with plant layouts; to survey every on-track plant burning gas and oil as a potential coal consumer; to solicit their conversion to coal where the economics of the situation give us a fighting chance; to follow up leads on new construction by making presentations on the advantages of burning coal to those responsible for fuel selection; on instruction, to work with your personnel on coal plants threatening to go to oil or gas; and to make speeches before civic groups. At night and on week-ends, these men write informative reports and prepare plant layouts.

Summing up BCI results for the first quarter: In new construction, we have obtained over 500,000 tons of new coal business and lost less than 100,000 tons for a ratio of better than 5 to 1. On the conversion front: Gas took 14 accounts from us and oil, 3, for a total of 27,550 tons. For our part, we captured 6 oil and 2 gas customers, plus 1 anthracite account, for a total of 119,500 tons. This is a tonnage ratio of over 4 to 1 in our favor. In addition, over 250,000 tons of coal consumption were saved from conversion.

Results of this kind can only be achieved through cooperative action—our people working with industry representatives at all levels. Together we are making an effective team, one that is worrying the gas and oil industries as we know from articles and editorials appearing in their trade journals and from the intensification of their own promotional efforts.

The economic position of the industry may prevent us from expanding our activities at this time or even require some curtailment. However, may I remind you the industry is spending over $50,000,000 per year to compete with each other for share of the existing coal business, while we have available less than 1% of that amount to sell the use of coal in new installations, capture markets now enjoyed by our competitors, and help save business threatened by oil and gas.

There is no surer highway to economic disaster for any industry than to fail to carry on an aggressive market promotion program. We make no promises, we make no predictions, but the Marketing Dept. pledges untiring efforts to provide this industry with the most efficient market promotion program of which we are capable with the tools supplied.

Law

R. E. L. Hall, general counsel; R. L. Hirshberg, assistant general counsel—The NCA Law Dept., as it is now known, was established approximately 20 yr ago, and its scope of operations, functions and limitations are much the same today. Moreover, the size, and makeup and staff requirements have remained unchanged by the reorganization. However, the addition of eight coal industry organizations to our corporate structure has meant additional legal responsibilities and obligations to NCA membership. We welcome the challenge of such additional responsibility and will make every effort to expand and improve our legal services on your behalf.

A most important work of the association—past, present and future—is in the field of federal and state taxation. The full force of the Law Dept. is necessarily brought into play when the government proposes changes in the Nation's tax structure or when changes are needed for the relief of the corporate taxpayer.

We believe great benefits have accrued to the coal industry as a result of our activities during the year in connection with percentage depletion, excise taxes, state taxation of interstate commerce, exploration expenditures, general tax revisions, and in every other phase of the ever-changing tax laws. Much important work has also been done with respect to Treasury regulations and interpretations of sections of the Internal Revenue Code affecting the coal industry. Certainly, keeping the industry advised of such developments is an important department function, in and of itself.

The form of our tax structure will continue to be of prime importance to the industry, since it appears that tax rates will be high for the foreseeable future. The principle of percentage depletion is constantly under attack from all sides and quarters. The increasing cost of the social security program will eventually result in still more discrimination against high-labor-cost industries such as coal, unless some method of financing the program (other than direct payroll taxes) is found. Proposals for a general overhauling of the tax system are increasing, and it is essential that the industry's views be presented adequately and that the industry be kept constantly advised of proposed amendments in this field. The association's Special Tax Committee of about 25 members is composed of outstanding tax experts and NCA members benefit from this wide cross-section of available expert opinion on tax questions.

If your lawyers or tax advisers are not on this list, please let us know and they will be added immediately. If you have any ideas or suggestions on the improvement of any of our operations, please do not resitate to give us the benefit of your views.

Economics and Transportation

Myles E. Robinson, director—The Dept. of Economics and Transportation was established Mar. 1, 1960 by combining the Departments of Coal Economics and Transportation. Most of the functions and some of the staff of the latter department were transferred to the new organization.

Our activities are three types: statistical studies and reports, analyses of trends and relationships among competitive fuels, special projects. While we expect to expand our statistical services in transportation to a degree more closely approaching those in economics, the relatively short time since the merger of the two departments has prevented much progress along this line. Publications and work of the department include the following:

Current Coal Trends is published monthly and contains those statistical series most frequently used by the membership.

Bituminous Coal Data, an annual publication, was started to place in the hands of members all important data from the Bureau of Mines, Census Bureau, Bureau of Labor Statistics, etc.

Steam-Electric Plant Factors, the most widely used of our annual reports, shows individual electric-utility-plant fuel consumption, the nature and extent of generation by each type of fuel, and the relative costs of using each.

Direct Sales of Natural Gas to Industrial Users is published to aid members concerned with the expansion and sales of natural.

Trends in Electric Utility Industry Experience, 1946-58, published in January, shows postward trends in electric utility use of various fuels on a state and regional basis. Much work remains to be done in this area. Because of the magnitude of this task and the commitment of our staff

to certain other projects, it will be some time in the winter before we are able to bring out the first of these new reports, which is to cover the three Middle Atlantic States.

The dept. has three long-range objectives, which will take time but should be attainable:

1. To become a central or focal point for the collection, analysis and distribution of complete and accurate industry statistics. If successful, we could in time become the authoritative source for such data.

2. To make special studies on competitive fuels, markets for bituminous coal, transportation problems, and other areas of interest or concern to the bituminous coal industry.

3. To serve as a clearing house for industry forecasts and to make these projections ourselves as a guide for industry planning.

The dept. always welcomes suggestions as to either content or manner of presenting statistical publications.

Research

James R. Garvey, director—At the BCR annual meeting, the member companies approved actions of its Board of Directors leading to affiliation with the National Coal Association. This culminated over a year of meetings and discussions pertaining to the mechanics of integrating research into the overall unified NCA structure. The establishment of a Research Dept. reporting to the NCA President, and retention of BCR as a corporation with its own Board of Directors, satisfies the need for closer coordination of coal association activities and, at the same time, enables continuing BCR support from non-industry sources.

Time does not permit a detailed description of all BCR research. But a brief statement regarding the following several current project will illustrate the scope of activities:

1. A project co-sponsored by the electric utility industry has provided much needed basic information on the mode and occurrence of sulfur in coal and on the problems of reducing air pollution from utility stacks. In the opinion of representatives of the utilities, the research progress has been significant.

2. The coal-fired package boiler has proven to be a technical accomplishment. Approximately 40 units now operating have demonstrated the competitive possibilities of coal in the small- and medium-sized commercial market. Additional manufacturers are now preparing to make similar automatic equipment available.

3. Many plants, both utility and industrial, have realized substantial benefits from the installation of BCR Easy-Flo Bin discharge devices in their coal storage bins. By thus eliminating a costly coal handling problem, research has added to the suitability of coal for steam generation.

4. Through careful study of a new device for railroad car sampling at dumping points, particularly dockside, it appears that research may provide a means for eliminating the age-old opinion difference between supplier and buyer as to the quality of coal shipments. This project has also served to emphasize the close relationship of research to marketing.

5. A device developed by BCR for continuously recording coal moisture in a moving stream of coal has been successfully applied at several preparation plants. This device not only provides a printed record of moisture in coal as it is loaded but also serves as a control for dryer operation.

6. The development of a means for continuous fracturing of coal in advance of loading has resulted from a cooperative research program with a leading explosives manufacturer. Originally started by the Mining Development Committee, this program has been advanced by BCR to the point of demonstrating feasibility. Several mining equipment manufacturers have expressed interest in participating in a study of application of this novel mining idea.

Areas for future coal research are abundant. Better equipment for mining and utilization of coal to maintain and improve present markets, and better processes to develop new markets will be the objectives of the NCA-BCR research program. We know that a real service to the industry in this direction can be rendered by combining the proven features of the past BCR General Research Program and other research groups such as the MDC and LDC, with the spirit of close cooperation expressed NCA's marketing and other departments.

It must be emphasized that research by itself never has and never will develop new markets. The uses to which research developments are put will determine the success or failure of any research program. We who have been closely associated with coal research are certainly aware that there is unfortunately no magic formula for achieving commercialization of research results. The coal industry must acknowledge that laboratory research is only part of an overall effort, and that neither BCR nor any other industry-wide association can do the job that is needed.

We are enthusiastically optimistic over the future of coal industry research as a part of the integrated NCA program. We feel this program will not only lead to selection of projects of greater industry significance, but will also provide the necessary recognition of what is required to achieve full commercialization of research investments. We are looking forward to discussion of research direction with industry executives with whom we have not been closely associated in the past. We are confident that an effective program will result.

Public Relations

Rex Chaney, director—Only a short time ago coal figured in the news only when there was a major strike or a mine disaster. Many of our citizens thought of coal as a sick and dying industry. Those of us in the industry knew better but the public did not. More recently, however, our broad public relations efforts have begun to get positive results. Our people and our government are beginning to get the idea that there is a strong coal industry today and that it is a major factor in the Nation's economy.

Our public relations activities are based on the premise that before we can convince Congress, or the public, that the coal industry is entitled to an equitable depletion allowance, research assistance, a national fuels policy study, or just anything else, except a passing mention in history books, we must first get across the point that there is a coal industry, that it is modern and progressive, has good prospects for the future and is essential to the America of the space age.

Our industry is unique in that few individual companies have strong public relations programs of their own. Unlike our oil and gas competitors, who have big individual public relations programs, most coal companies leave the bulk of their public relations efforts to the National Coal Association. We welcome this challenge even though we would like to see more individual company emphasis on public relations.

To achieve a favorable public impression of the coal industry, we use a variety of tools: Press releases, pamphlets, booklets, advertising speeches, photographs, films, television clips, radio interviews, educational pamphlets and exhibits, and personal contacts. We are constantly seeking new methods and techniques to add to our arsenal of public relations tools.

I would be the first to say that we do not do enough in this vitally important field. We should have more films, more advertising, more speeches, more material for magazines and more time to devote to our education program—but we must also live within our budget. We are proud, however, of what we have been able to accomplish with the money available in the last 2 yr. We deeply appreciate the support given to us . . . and we look forward to to doing an even better job in the future.

Open Pit Mining Association Electrical Division reviews . . .

Power Distribution, Grounding Systems and Controls



POWER, GROUND PROTECTIVE SYSTEMS—Dr. T. F. Jones (left), Purdue University, West Lafayette, Ind.; S. C. Cooke Jr., General Electric Co., Chicago, Ill.; G. H. Utterback, master of ceremonies, The United Electric Coal Cos.; A. C. Lordi, Westinghouse Electric Corp., E. Pittsburgh, Pa.; E. T. Groat, General Electric Co., Chicago, Ill.; and Vernon Hendrickson, Pittsburg & Midway Coal Mining Co., Madisonville, Ky.

TRENDS in open pit power distribution, ground protective systems and the principles of modern control for large excavators highlighted the 16th annual meeting of the Electrical Div. of the Open Pit Mining Association at W. Lafayette, Ind., June 9, on the Purdue campus.

Over 170 electrical engineers, chief electricians and manufacturers from 27 states plus 60 wives gathered at Purdue University's Memorial Center to participate in the activities. Dr. T. F. Jones, head, school of electrical engineering, Purdue University, welcomed the group and G. H. Utterback, secretary-treasurer, The United Electric Coal Cos., Chicago, Ill., served as master of ceremonies. E. T. Groat, sales engineer, General Electric Co., Chicago, Ill. was chairman of the morning session. Dr. George E. Davis, director, division of adult education, Purdue University, was speaker at the banquet.



OFFICERS—Vernon Hendrickson (left), outgoing president, Pittsburg & Midway Coal Mining Co., Madisonville, Ky.; T. Elmer Davis, president-elect, Stonefort Coal Mining Co., Inc., Stonefort, Ill.; Harry W. Carey, vice president-elect, Peabody Coal Co., St. Louis, Mo.; L. E. Briscoe, re-elected secretary-treasurer, Ayrshire Collieries Corp., Inc., Indianapolis, Ind.

New officers elected for the coming year are:

President—T. E. Davis, electrical engineer, Stonefort Coal Mining, Co., Inc., Stonefort, Ill.

Vice President—Harry W. Carey, electrical engineer, Peabody Coal Co., Greenville, Ky.

Secretary-Treasurer—L. E. Briscoe, electrical engineer, Ayshire Collieries Corp., Inc., Indianapolis, Ind.

Abstracts of the papers follow:

Trends in Open Mine Power Distribution, A. C. Lordi, mining industry engineer, Westinghouse Electric Corp., E. Pittsburgh, Pa.

To supply the large fluctuating loads represented by large shovels with their attendant auxiliary equipment loads, requires that the distribution system be planned more carefully than ever before. Safety, capacity, flexibility, equipment protection and voltage regulation become increasingly important.

The power demands of a shovel or dragline vary over a wide range during each operating cycle, from high peak loads of 200% rated horsepower during digging and hoisting, to negative regenerative loads approaching 80% of rated horsepower when plugging takes place. Cycle times of large shovels and draglines range from 45 to 70 sec.

To help maintain voltage within reasonable limits during these wide load fluctuations, kvar compensators or regulators are used to increase synchronous m-g set drive-motor field excitation during peak loads, increasing leading kvar; and to decrease field excitation at light loads to reduce leading kvar. This changing of reactive kva during load fluctuations helps compensate for voltage regulation occurring in the transformers and transmission lines due to their inherent inductive reactance.

The large excavator m-g set AC drive motors are usually full-voltage-started,





MODERN CONTROLS, IDEA FORUM—G. H. Utterback (left), session chairman; Prof. Charles Siskind, Purdue University, W. Lafayette, Ind.; L. A. Selleg, forum moderator, Westinghouse Electric Corp.; T. E. Davis, Stonefort Coal Mining Co.; J. C. Rettenmayer, The United Electric Coal Cos., Canton, Ill.; R. M. Leseney, Truax-Traer Coal Co., Fiatt, Ill. In the right photo are Richard Stokes and R. T. Taylor, Peabody Coal Co., St. Louis, Mo.

requiring from 350 to 450% inrush at approximately 30% lagging power factor. In excavators presently using up to 3,500 hp in a single motor, full voltage inrushes may reach 12,500 kva. Spoor power-factor load of this nature suddenly applied results in an appreciable shock to most utility systems as well as to the mine distribution system. The local utility should be made aware of the starting requirements as well as the normal load swings of the excavators early in the planning stages of the distribution system.

To provide the large blocks of power demand by modern mines, utilities usually supply power to the mine at a transmission line voltage ranging from 22.9 to 115 kv. Thus a substation is required to reduce the incoming voltage to the distribution rating which can safely be handled for the portable loads.

The use of a primary circuit breaker instead of primary fuses is desirable to better protect the substation apparatus.

The modern trend is toward the 3-phase transformer. The use of single-phase transformers is being abandoned because of higher initial and installation costs. Also, 3-phase transformer substations are more easily relocated.

In line with the trend to higher voltages, the 13,800-V distribution system must be seriously considered.

The modern distribution system is safety resistance grounded. The use of the resistor has become more and more accepted as the safety advantages are more realized.

The trend in breakers has been more to the air breakers built into packaged substations. As with other substation components the breaker sizes have been increasing to handle the increased fault and thermal capacities required.

A recent trend to increased use of ground-wire monitor schemes to isolate the system in event of an open in the ground wire has been noted.

The trend to larger substations has been accompanied by the increased use of unit substations. Installation is easier and moves are facilitated.

Where power is fed to the stripping shovel at 7,200 V, portable substations in the pit may be required for lower distribution voltage to feed existing equipment rated for lower voltage. Another possibility which merits consideration is the use of a shovel-mounted transformer which would eliminate the need for a portable substation.

The trend in portable mine power centers is to the use of safety resistance grounding. Also, the use of balanced-flux ground-fault relaying or individual feeder circuits is increasing.

The trend in power transmission is toward the use of cables only from the main substation minimum. Lightning exposure also is minimized. Cable couplers have met increased acceptance and the trend has been toward the greater use of multi-conductor couplers.

Elements of the Ground Protective Systems and Some Unsafe Practices Observed in the Field, S. C. Cooke Jr., application engineer, distribution systems, General Electric Co., Chicago, Ill.

The purpose of a safety ground is to prevent development of lethal shock. But a safety ground system will not protect a person who contacts energized phase conductors.

In a safety ground system it is important that the neutral conductor be fully insulated. It must be copper and located where it is visible for inspection.

A grounding resistor limits the ground-fault current so that the potential from frame to ground is held to a maximum of 100 V. Some systems rely on 50 amp and 2 ohms, whereas others employ 25 amp and 4 ohms. The higher amperage is sometimes desirable because as much as 80% protection by relaying devices is possible.

The earthing point of a grounding system should be at least 50 ft from and not connected to the substation ground.

In an all-cable system special precautions must be taken at the substation to separate the two grounds. It is also very important to connect the ground wires when joining cable sections.

Protective equipment should include circuit breakers at each branch line and the backup circuit breaker at the main substation. Selectivity in operation also is important in protective equipment so that healthy equipment can continue to operate.

All components at the main substation must be periodically inspected, including checking relays, resistance of the ground, continuity of the ground and so on.

The same basic principles apply to low-voltage as to the higher-voltage circuits. There are two ways of supplying the lower voltage when the main system is 7,200 V. These include a skid-mounted transformer and protective system or a step-down transformer mounted on the machine itself.

One problem that comes up when stepping down voltage from a Y primary to a delta secondary is the need for a zig-zag transformer.

The most common unsafe practice noted in the field is the failure of some companies to provide separate grounds for the main substation and for protection. The separation is needed to minimize the effects of primary ground faults and substation surges on the safety ground wire. A minimum distance of 50 ft between grounding points is recom-

(Continued on p 174)



EDUCATION, RESEARCH—Ernest Kirkendall (left), secretary, AIME, New York; E. M. Spokes, University of Kentucky; T. C. Miller, U.S. Bureau of Mines; E. P. Bucklen, Pocahontas Fuel Co., and Monroe Rule, National Gypsum Co.

Central Appalachian Section, AIME, convenes on . . .

New Ideas in Mining

APPLICATIONS of types of continuous-mining machines, improved mine ventilation, the use of computers in mining and the inducements that might be offered in promoting the study of mining engineering were among major themes of the technical sessions of the Spring meeting of the Central Appalachian Section, AIME, at Abingdon, Va., June 10-11. Chairman of the section is W. J. Skewes, chief engineer, Pocahontas Fuel Co., Division of Consolidation Coal Co., Pocahontas, Va. Heading the program committee are D. C. Ridenour, general superintendent, Olga Coal Co., Coalwood, W. Va., and W. S. Hannan, New Jersey Zinc Co., Austinville, Va.

Chairman of the Friday morning session was Monroe Rule, plant manager, National Gypsum Co., Kimballtin, Va. Abstracts of the proceedings follow:

Inducements to the Study of Mining Engineering, E. M. Spokes, professor of mining engineering, University of Kentucky, Lexington, Ky.

Enrollment in mining-engineering courses is much lower today than it was a few years ago. In 1935 there were 2,245 mining students in the Nation's colleges; in 1959 there were 951 students in mining. The 1935 figure represented more than 2% of all students enrolled in engineering courses; the 1959 enrollment in mining is less than ½% of all students in engineering. Predictions of increasing demand for minerals in the future and the increasing difficulty of recovery point up the need for increased enrollment in mining.

Properly advertised scholarships should attract an increasing number of students. Surveys of the situation show that right now only 35% of recent mining graduates are self-financed, the others receiving assistance from one or more sources.

Positive steps can be taken through better vocational counselling at the high school level, with industry taking an active interest in this pursuit. Companies can take steps to provide counsellors with good literature and opportunities for productive mine visits. Counselling through friends and relatives now engaged in the industry and through the extension of applicable hobbies into career-starters can be employed.

Negative aspects must be counteracted. Mining communities can be spruced up, a step which requires only the removal of eyesore buildings that are no longer in use. Mining companies must put up attractive fronts to compete in the market for brains. Furthermore, hand-labor training programs should be reevaluated. "If you buy brains, use them on engineering jobs."

INDUSTRY MEETING—
A Special COAL AGE Staff-Written Report

Application of Computers to Accounting, Operating and Engineering, E. P. Bucklen, special engineer, Pocahontas Fuel Co., Pocahontas, Va.

Progress in computer design and application is almost unbelievable. Although the machines can do no calculations that man cannot do, they can perform much faster and with more accuracy. In payroll preparation at Pocahontas Fuel Co. computers handle 48 possible payroll deductions, from punched cards to written checks, carrying totals to date where this information is required. All steps in billing and in processing accounts payable are handled on the machines. Applications to which the machines can be put depend only upon the skill and imagination of the machine-records personnel.

At Pocahontas Fuel curves have been developed through the use of the machines that show the necessary investment in supplies and parts that must be carried to achieve a desired level of performance in operations. The equipment also is used to calculated elevation and area surveys and in contouring. A 150-station survey can be calculated in 2½ min on the machine, with preparation of punched cards requiring about 15 min.

Plans are underway to use the computers to eliminate planimeter work, and to extend their use to the evaluation of changes in ventilation systems before the changes are made.

Sonar Exploration of Roof Rock, Dr. C. E. Mongan Jr., consulting physicist, and T. C. Miller, health and safety engineer, U. S. Bureau of Mines, Pittsburgh, Pa.

Theory and experiments in the laboratory and in the field indicate the practicability of exploring roof-strata using sonic techniques and equipment. This is a system of generating a sonic or ultrasonic beam, shaping the beam and introducing it into the strata to be studied. Return waves from the strata are picked up by a receiver with the aim of establishing the nature of the material traversed by the sound waves. Presence and locations of interfaces or obstacles in the strata can be fixed.

Tests at Bruceton tend to confirm the usefulness of the method. Now being studied are designs for lighter, more compact equipment for underground use. No great difficulties have been encountered in using the equipment in gassy or dusty atmospheres.

Continuous Mining

Chairman of the Friday afternoon session on continuous mining, covering applications of a number of different machines, was P. E. Watson, assistant general superintendent, United States Steel Corp., Gary, W. Va. Abstracts of the papers are as follows:



CONTINUOUS MINING—Martin Valeri (left), Buckeye Coal Co.; E. W. Potter, Royalty Smokeless Coal Co.; K. S. Hobbs, Eastern Gas & Fuel Associates; E. V. Bowman, Winding Gulf Coals, Inc.; R. W. Worting, Olga Coal Co., and P. E. Watson, U. S. Steel Corp., session chairman.



VENTILATION—W. E. Foreman (left), and T. Carl Shelton, Virginia Polytechnic Institute; Leonard Sargent, Pocahontas Fuel Co.; William Poundstone, Christopher Coal Co. and George Price, U.S. Bureau of Mines

Joy 6-CM Miner in the Pittsburgh Seam, Martin Valeri, superintendent, Nemacolin mine, Buckeye Coal Co., Nemacolin, Pa.

The 6-CM has been in operation at Nemacolin since November, 1959. Average production is 575 tons per shift, raw coal; peak production was 848 tons in one shift. The face crew consists of seven men. The machine is used in retreating blocks of coal 86x86 ft in area. The system is based upon holding a few inches of top coal and the drawslate in place to get a better product (lower sulfur) from the cleaning plant. Power is provided by a 600-kw substation on the surface. Voltage is 250 V at the machine, average load is 600 amp.

A typical shift operation (day shift) showed the following:

Tonnage—654 tons; face crew—7 men; loading rate—3.27 tpm; tons per man (face crew)—93.4; tons per man (section crew)—72.7.

The time study showed the following:

Loading—200.8 min; swing—43.3 min; maneuvering—19.0 min; car change—8.2 min; place change (tram and handle cable) 27 min; timbering — 32.5 min; grease and change bits—15.2 min; delays in loading—12.0 min; waiting for cars—24.6 min.

Total available face time—382.6 min; fixed delays—97.4 min; total shift time —480.0 min.

Lee-Norse Miner in the No. 4 Pocahontas Seam, Robert W. Wotring, superintendent, Olga No. 2 mine, Olga Coal Co., Caretta, W. Va.

Mining thickness is from 5 to 6 ft. Latest machines in service are three Lee-Norse Model CM37X Miners, each weighing 51,000 lb. Height of the machine is 40 in and length 32.5 ft. Maximum cutting height is 102 in and minimum is 40 in. Maximum cutting width is 102 in. The machine is hydraulically powered throughout with power supplied by three 50-hp motors.

Blocks retreated by the machines are 72x57 ft in area. The coal is subject to bumping if care is not taken to keep the open cut always ahead. In other words, no pocketing is done. Pillar lines are flat.

Based on experience with CM33X Miners, it is projected that the newer CM37X machines will produce 200,000 tons—and possibly 300,000—before overhaul is required. Productivity with the new machines has been very good both in development work and in pillars. One machine, working a half month in development and the other half in pillars, loaded 15,384 tons in 36 machine shifts, for an average of 427.3 tons per machine shift and 49.42 tons per production man per shift.

Percentage of recovery has been equal to or better than that achieved with other types of machines. This results from the fact that fewer stumps are lost because the pillars are mined before they have had time to take weight.

Continuous Mining in Seams Less than 38-In Thick, K. S. Hobbs, superintendent, Eastern Gas & Fuel Associates, Helen, W. Va.

Operations at Stotesbury No. 10 are in the Pocahontas No. 4 seam which ranges in height from 31 to 40 in and averages 34 in. Main mining units is an 86A Colmol with a cutting range of from 28 in to 44 in. The machine discharges coal over a bridge conveyor to a chain conveyor in the room. The chain conveyor is equipped with a crawler-mounted drive to reduce the time required in moving the set-up to new rooms.

Rooms are driven 28 ft wide on 60-ft centers to a depth of 325 ft. Breakthroughs are driven at 60 deg by single passes of the Colmol as the room is advanced. When the room is driven to its limit it is fanned out and the pillar is brought back in lifts parallel to the breakthroughs. The room set-up is moved daily since in two shifts the room can be

driven and the pillar fully recovered.

The crew consists of 5½ men. Average shift production is 472 tons over the 8-mo term of use of the Colmol, although peaks of 700 tons per shift have been reached several times. The crew consists of a foreman, a Colmol operator, two pan-up men, a timberman and half the time of a cleanup man. Roof is supported entirely on posts and cribs.

Loading time amounts to 45.65% of total time, and panning requires 15 % of total time. A system for more continuous transportation now is being studied to make it possible to convert this panning time to loading time.

The Wilcox Miner, E. P. Bowman, vice president, Winding Gulf Coals, Inc., Tams, W. Va.

Winding Gulf Coals employs two Wilcox Miners in the Beckley seam. The coal is a low-volatile, low-sulfur coal which is needed for blending even though mining conditions leave a lot to be desired. The coal lies in ridge tops which have been contour-stripped by contractors. Openings consists of four entries from the highwall and 30-ft rooms on 40-ft centers. Places are timbered on 4-ft centers leaving an 8-ft-wide roadway. There are five face men per miner and a total of 33 men employed at the mine on all shifts. Through April 30, after 188 days of operation, the record showed an average of 801 tpd. The highest production was 1,300 tpd.

Labor cost averages $1.34 per ton and $.25 per ton for moving the equipment. Maintenance costs average $.11 per ton for parts and $.012 per ton for bits. The coal is friable and has a grindability of 90.

Problems of supplying the operation have been substantially reduced through the use of Kersey supply tractors.

The Terrell Miner, E. W. Potter, vice president and general manager, Royalty Smokeless Coal Co., Clifftop, W. Va.

The need at Clifftop was to get a machine with a cutting head that would reduce the amount of ¼x0 produced from the 36-in Sewell seam. A drawslate roof requires close support. The use of the Terrell miner has resulted in a reduction of from 8 to 10% in the amount of ¼x0.

Basically the machine is a Gooodman 512 with a special cutting head that attacks the coal head-on while sumping, then is turned 90 deg to cut across the face. After a cut is completed, the head is again turned to the head-on position for a new sump, after which the head is rotated 90 deg in the opposite direction and a new cut is made across the face back to the original side. The machine discharges to a bridge conveyor at a pivot point where the machine and bridge are jacked down. Conventional shortwall ropes pull the machine back and forth through its cutting cycles. A conventional chain cuts a kerf at the bottom and a circular trimming head trims the roof.

A crew consists of three men who make an 18-ft advance in 130 min for 54 tons of coal. After each 18-ft advance conveyor pans must be added to the room conveyor. The machine has a potential capacity of 160 tons per shift in these conditions. Average now is about 125 tons per shift.

Ventilation

The Saturday morning session was in charge of Chairman T. Carl Shelton, assistant professor, Dept. of Mining Engineering, Virginia Polytechnic Institute, Blacksburg, Va. Abstracts of the proceedings are as follows:

Ventilation in Conventional Development of Gassy Coal Seams, by Leonard Sargeant, ventilation engineer, Pocahontas Fuel Co., Div. of Consolidation Coal Co., Pocahontas, Va.

Methane in the Pocahontas field is generally confined in the coal itself, rather than in mud slips or clay veins. Therefore, the coal retains the methane until it is broken out of the solid. For this reason there is little point in developing entries around large blocks of solid coal to bleed the blocks. In fact, methane is sometimes liberated when chain pillars and barriers are finally taken.

The company has standardized ventilation practices for 5-, 6- and 7-heading development. The cycle of operations is designed so that air from a face being shot or cut is not carried back over electrical machinery, except in the case where a center heading is shot with the loader in No. 1 Heading in a 7-heading system.

The seven headings in the mains are all intakes. Parallel 5-heading entries are driven on both sides to serve as returns. Barrier pillars 150-ft thick separate the returns from the intakes to eliminate the need for maintaining lines of permanent stoppings. Submains are turned at 90 deg to the mains, and all overcasts are blocked out and the top prepared during initial development of the mains.

Brattice cloth is securely hung from header boards installed with the rib row of roof bolts. Air is brought up the tight side and posts are set at corners of the line curtain to keep trailing cables of shuttle cars from collapsing the curtains. Strict supervision of brattice installation is a feature of the Pocahontas ventilation program.

Face Ventilation in Development With Continuous Miners, William Poundstone, Christopher Coal Co., Morgantown, W. Va.

Problem of liberation of large volumes of methane was chief concern of Christopher officials when continuous mining was adopted. However, events have shown that concentration of operations in one working place is the key to success in very gassy seams.

Adequate volume of air is first necessity, and a system must be devised to provide an uninterrupted flow to every portion of working section. At Humphrey, basic plan of operations involves blocking out large areas of coal with encircling headings to bleed gas from the area prior to pillaring. Line curtains are employed to conduct air to working faces, with intake air coming up the wide side, passing over the face equipment and out behind the line curtain to the returns.

It has been found that leakage through pores in brattice cloth can be reduced by applying a very thin plastic sheeting to the pressure side of the brattice. It can be held in place by the pressure differential across the curtain. The area behind the canvas also is important in getting maximum ventilating air to the face. The equipment in use at Humphrey permits the use of larger areas behind the canvas and makes it possible to extend the curtain closer to the face.

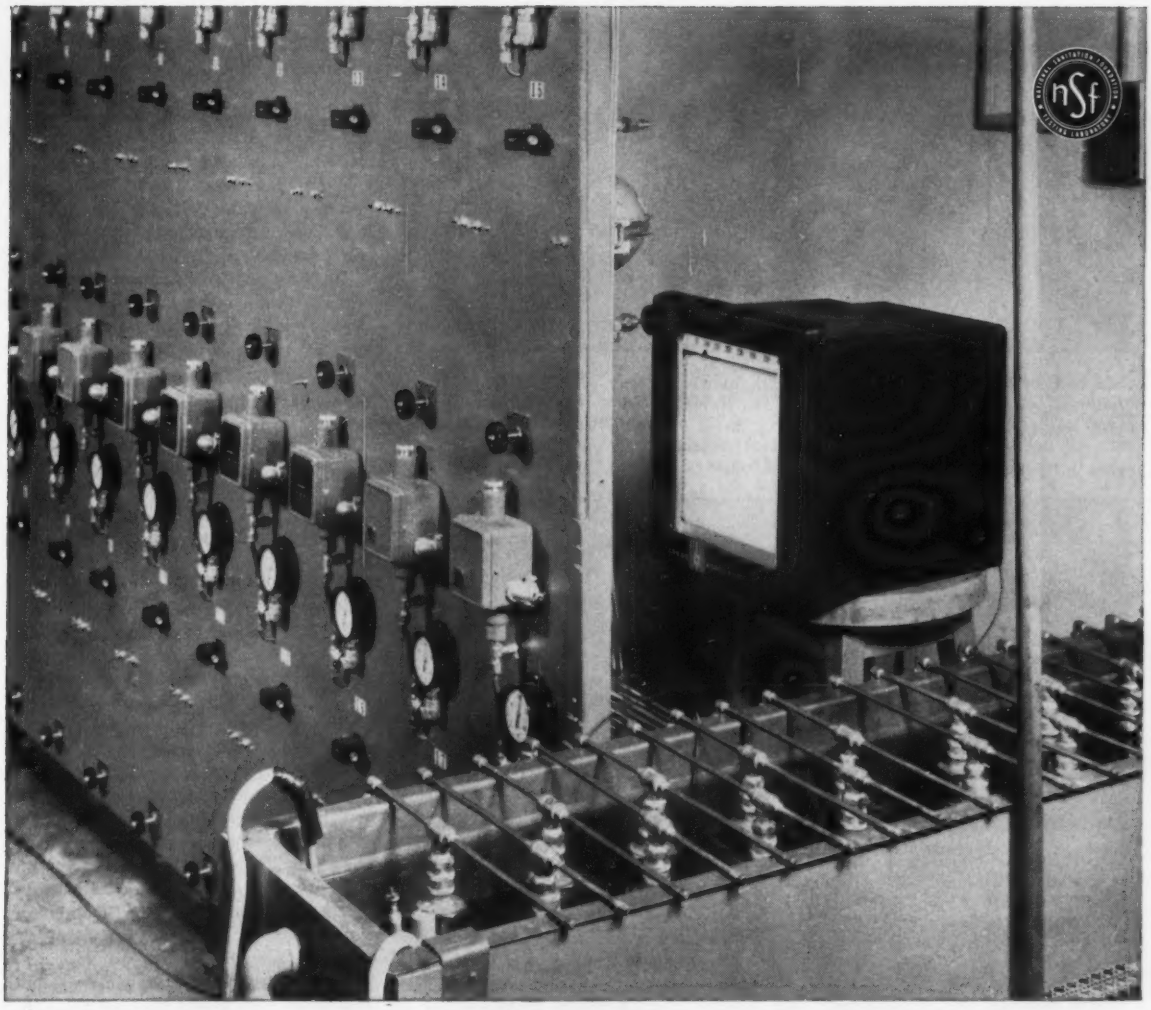
For the past year the company has followed the practice of drilling 2-in bleeder holes in advance of the face in headings adjacent to virgin coal. This bleeds methane from the solid directly into the returns, thus improving section conditions.

Flotation of Fines, W. E. Foreman, Dept. of Mining Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

Paper centered on flotation of extreme fines in the minus 10-micron range, followed by centrifuging of froth to separate solids. Research to date applies mainly to copper and zinc ores, but can be extended to coal.

Hydraulic Mining of Coal, George Price, mining methods research engineer, U. S. Bureau of Mines, Pittsburgh, Pa.

Concluding feature of the meeting was a motion picture, narrated by Mr. Price, on the Bureau's experiments with hydraulic mining in the Pittsburgh seam near Indiana, Pa. The method now is being tried in an anthracite installation. (see *Coal Age*, March, 1960, p 124.)



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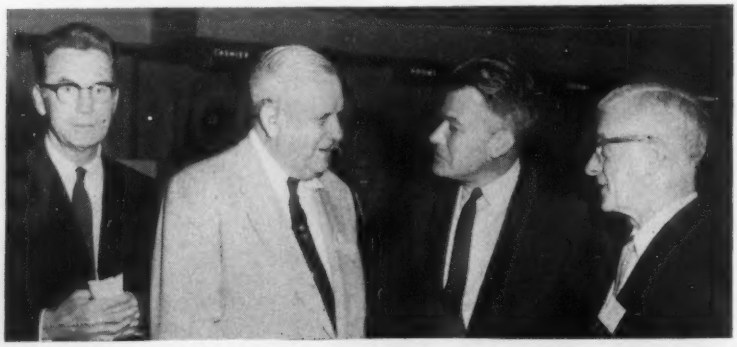
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SAFETY FOREMOST—C. A. Purcell (left), Indiana Bureau of Mines; C. H. Hoch, National Safety Council; E. N. Connor, Pa. Dept. of Mines; G. J. Steinheiser, Pa. Dept of Mines, and MIIA president-elect; L. W. Schuler, United Mine Workers; Murrell Reak, Illinois Dept. of Mines; H. A. Schrecengost, U. S. Bureau of Mines; Paul C. Lingo, W. Va. Dept of Mines, and Domenic Stanchina, Ohio Division of Mines.



GREETINGS—Hon. Bert T. Combs (second from right), governor of Kentucky, welcomes A. H. Mandt (left), commissioner, Ky. Dept. of Mines and Minerals; G. H. Deike, Mine Safety Appliances Co., and chairman of MIIA finance committee, and Arthur Bradbury, Inland Steel Co., and retiring president of the institute.

50th Annual Convention of Mine Inspectors places . . .

Safety in the Spotlight

STATUS of the national roof-fall prevention campaign, the elements of safety programs in the various states and new developments in enhancing safety in mining operations were among major topics presented by speakers at the 50th annual convention of the Mine Inspectors' Institute of America at Louisville, Ky., June 13-15. Highlights of the program were first public descriptions of experiences with fire-resistant hydraulic fluids in underground applications and with the airslide method of handling and applying rock dust in bulk.

At the institute business session, officers were elected for the coming year as follows:

President—**G. J. Steinheiser,** inspector, Pennsylvania Dept. of Mines and Mineral Industries, Uniontown, Pa., succeeding **Arthur Bradbury,** assistant manager of coal properties, Inland Steel Co., Wheelwright, Ky.

First vice president—**Robert D. Bradford,** supervisor, U. S. Bureau of Mines, McAlester, Okla.

Second vice president—**C. A. Purcell,** director, Indiana Bureau of Mines, Terre Haute, Ind.

Third vice president—**J. A. Boyle,** chief mine inspector, U. S. Steel Corp., Pittsburgh, Pa.

Secretary—**Joseph Bierer,** Mt. Storm, W. Va.

Secretary-Emeritus—**C. A. McDowell,** California, Pa.

Assistant secretary—**Joe Mulligan,** safety inspector, Semet-Solvay Div., Allied Chemical & Dye Corp., Montgomery, W. Va.

Treasurer—**James H. Close,** Maryland Bureau of Mines, Cumberland, Md.

Editor-in-chief—**Stanley Mooney,** safety director, Woodward Iron Co., Woodward, Ala.

Publicity editor—**W. J. Schuster,** St. Clairsville, Ohio.

Chairman of the welcoming session was Mr. Bradbury, retiring president of the institute, who responded to personal greetings from Hon. Bert T. Combs governor of Kentucky, and Col. R. C. Bing, administrative assistant to the mayor of Louisville.

Chairmen of the technical sessions were Messrs. Steinheiser, Bradford and Purcell. Abstracts of the proceedings follow:

The National Campaign

Causes of Roof-Fall Injuries, Harry A. Schrecengost, technical assistant, USBM, Washington, D. C.

During the 50-yr life of this institute approximately 82,000 men have lost their lives in the Nation's coal mines, about half of these fatalities resulting from falls of roof. Investigations reveal that roof-fall fatalities result from a combination of circumstances. Each of the 153 roof-fall fatalities that occurred last year was a result of human failure. Tables show only primary causes, and do not reflect the combinations of circumstances.

Systems of mining, fatalism, unrealistic dependence on "experience," and sometimes dependence on inspection to support the roof can all be included as causes of accidents. Officials and workmen alike are exposed to the roof hazard. When we consider that the solution to this problem is simply the provision of adequate support, the removal of loose material or withdrawal of workmen, no reasonable person will say that roof-fall accidents belong in the "Act of God" category. The means for success in the campaign are at hand. Everyone must be sold on applying these means.

Role of the United Mine Workers, Louis W. Schuler, assistant to the director, Safety Div., UMWA, Washington, D. C.

"Unfortunately, many times when we are given an opportunity to express our views it is before an audience such as this where the majority of those present are cooperating in matters of safety. Your presence here demonstrates your interest, and I take this opportunity to commend those who are making a sincere effort to operate safe coal mines. We must, however, depend upon you to convey our displeasure to the balance of the industry who are content to see the accident statistics from roof falls continue year after year.

"The accident record for the period January-April, 1960, is not encouraging. The Bureau of Mines reports 106 men have already lost their lives, at a frequency rate of 1.14 per million man-hr

exposure. During the same period 66 roof-fall fatalities have been recorded, 17 more than the same period in 1959."

Kentucky's Participation, A. H. Mandt, commissioner, Kentucky Dept. of Mines and Minerals, Lexington, Ky.

Solution of the roof-fall problem is three-fold: (1) Education; (2) Training; (3) Inspection. These responsibilities rest squarely on the shoulders of state and federal agencies and operating companies. Several large Kentucky operations are making full use of all the materials offered by the Campaign Steering Committee through the National Safety Council. Notable records have been achieved where concerted effort to reduce the roof-fall toll has been put forth.

Kentucky inspectors personally contact each operator who has enrolled in the campaign to urge him to file all the required reports. Certainly a fallacy will result if final reports are filed only by those operations showing an improvement of record.

Progress Report, Clinton H. Hoch, staff representative, National Safety Council, Chicago, Ill.

Total enrollment in the 1960 Campaign includes almost 1,500 coal mines.

"Now comes the supreme test. Can we influence the mines to send in the necessary reports? Will the safety-consciousness generated by concentrating our efforts and activities on a specific hazard be sufficient to achieve the reduction of 50% or more in the frequency rate of injuries from roof-falls which is our campaign goal?

"This is a personal challenge to each one of us. Speaking in behalf of the National Safety Council, I can assure you that we will do our part. Our next activity, in addition to continuing publicity, will be to send a letter accompanied by injury report forms to all enrollees, urging them to submit their injury experience from Jan. 1 to Jun. 30. This report should be sent in by Aug. 15. Information from this report will be used to develop a bulletin giving the results of the first 6 mos of the campaign."

State Safety Programs

Lessons From Serious Occurrences, Domenic Stanchina, chief, Division of Mines, Ohio Dept. of Industrial Relations, Columbus, Ohio.

From experience we have learned that mine management must not evade its responsibilities in providing adequate ventilation, roof support and proper haulage and drainage facilities. Moreover we have found that negligence on the part of management breeds negligence in the employees, resulting in dangerous work habits. On the other hand, we have found that if a company sincerely attempts to maintain its mine and equipment in safe condition, the employees almost without exception will respond accordingly, provided the employees and supervisors are qualified men.

It is at this point that the work and purpose of inspecting a mine becomes effective, that is, by helping to train workers and supervisors. Therefore, inspectors are instructed to carefully observe the work habits of men with the hope and expectation of eliminating the causes of accidents.

Prevention of Fatal and Non-Fatal Injuries, Edward N. Connor, mine inspector, Pennsylvania Dept. of Mines and Mineral Industries, Nanty-Glo, Pa.

Management at all levels must take the lead in showing sincerity and determination in around-the-clock accident prevention. Management must lay out the program and provide the financial and moral support. Employees must provide the power to keep the program going. To make the program work, these men must obey the rules.

Training of new employees is the responsibility of management, as is the impartial enforcement of all safety rules. Discipline must be maintained if the prevention of accidents is expected.

How to Promote a Successful Safety Program, C. A. Purcell, director, Indiana Bureau of Mines and Mining, Terre Haute, Ind.

"I think we have to begin with people who manufacture machinery and tools with which men work." Manufacturers would do well to make a thorough, on-the-job investigation concerning the natural conditions and circumstances under which their products will be used.

Next, there must be 100% cooperation among management and workers. In Indiana, the "Joint Committee for Coal-Mine Safety" is a concerted effort by all agencies to increase the safety of underground operations in the state. The organization promotes, by various means, the education and training of all mining personnel.

In the 6 yr since the committee was organized there have been 20 fatalities in Indiana coal mines, 10 in the first year. In the 6 yr prior to the formation of the committee there were 87 fatalities in Indiana coal mines.

Outstanding Features in State Safety Programs, Thomas Allen, chief coal-mine inspector, Colorado, Denver, Colo.

A few years ago the department carried on safety training programs for the wives and families of miners. This work was conducted by a woman member of the department. Approximately 5,000 women were trained in first aid. They were also trained to respond in groups to emergency calls, taking care of the families of accident victims and providing food for rescue crews. Fortunately, there has not been a mine disaster in Colorado since 1942. One result of this training was a remarkable drop in the number of infections reported, which is attributed to better care of cuts and wounds at home.

Maintaining Face Ventilation in Gassy Mines Using Boring Machines, Paul C. Lingo, deputy director, West Virginia Dept. of Mines, Charleston, W. Va.

In tests jointly conducted by Mountaineer Coal Co., U. S. Bureau of Mines and West Virginia Dept. of Mines it was found that despite some difficulties a water injected dust collector on the mining machine has considerable potential in face ventilation. Presently available is a dust collector of this type weighing 1,600 lb which can be mounted on a skid or on rubber tires.

Indications are that the use of this unit in conjunction with a blower on the miner will provide a satisfactory arrangement in places with methane liberations of 35 cfm or less. However, the most effective system found thus far consists of a combination of fans, blowing and exhaust.

In this setup one line of tubing is carried right up to the face and the other is extended to the area between the miner and the pickup loader. Further aid to the fans can be provided by setting a short wing brattice in the crosscut to facilitate splitting the air current in the working place.

Developments in Mining and Safety Practices, Murrell Reak, assistant director, Illinois Dept. of Mines and Minerals Springfield, Ill.

Auxiliary blowers properly used can adequately ventilate places where continuous mining machines are in use. Among the rules which should be observed are these:

1. The fans should be permissible and be maintained that way.
2. They should be installed on the intake side of the entrance to the place to be ventilated.
3. Volume of air in which fan is placed should be least 2½ times the manufacturer's rated capacity of the fan.
4. The fan should operate continuously while the area affected by the fan is in operation.
5. If mine ventilation is interrupted while mine is in operation all switches should be manually opened.
6. If a blower fan stops during operations men should be withdrawn and power cut off from area affected by fan. Area must be examined by an official before restarting.
7. Tubing must be in good repair,



BLEEDER SYSTEMS—Leonard Sargeant (left), Pocahontas Fuel Co.; Robert D. Bradford, USBM; and Stephen Krickovic, Eastern Gas & Fuel Associates.



AIRSLIDE ROCKDUSTING—Ewalt Herzog (left), Hanna Coal Co.; Mr. Bradford, and G. L. Alston, Mine Safety Appliances Co.



MINE FIRES—Herbert A. Wendel (left), Anaconda Co., and Bernard W. Carey, Odanah Iron Co.



SAFETY AND RESEARCH—J. A. Younkins (left), Duquesne Light Co.; H. E. Mauck, Freeman Coal Mining Corp., and Mr. Purcell, vice president-elect of the institute

properly suspended and frequently inspected.

8. Inby end of tubing must be kept close to face, and fans must not be used to remove gas accumulations.

9. Rock dust and suitable fire extinguishers should be at hand.

Bleeder Systems

Ventilation of Gob Areas and Use of Bleeder Systems, Stephen Krickovic, director, engineering and development, Coal Div., Eastern Gas & Fuel Associates, Pittsburgh, Pa.

The immediate objective in bleeding should be to maintain a methane-free belt adjacent to the working places along a pillar line, so that in the event of a temporary interruption in face ventilation, the gas will not reach the workings during the interruption. This requires controlled movement of air, and control requires power since there must be a pressure differential to cause the desired flow of air. It is as just as important, particularly in gassy mines, to design a ventilating system that will satisfy effective bleeding requirements as it is to satisfy the air volume requirements in operating splits.

Whereas good design usually includes about 1 in w-g for the open split in an overall setup, bleeding of the most difficult panel may require an additional ½ in or 1 in w-g.

On the basis of ventilating a gassy mine with 400,000 cfm at 5-in w-g without regard for the bleeders, the extra power for the additional water gage would represent roughly 55 to 105 hp. This is a reasonable price to pay for one of the essential elements in effective bleeding. Too often bleeding becomes a secondary and incidental factor.

Certain effective plans include provision for a split of intake air in the bleeders to facilitate control and inspection and maintenance of regulators.

Formal Discussion, Leonard Sargeant, mining engineer, Pocahontas Fuel Co., Pocahontas, Va.

To properly design, maintain and construct any bleeder system the following points should be considered.

1. The seam conditions should be thoroughly analyzed to take advantage of natural drainage, roof conditions and character of overlying strata.

2. The general mining scheme should be projected to indicate periods when more than one unit will necessarily be retreating on the same gob area. When multiple units are employed on the same pillar line, consideration must be given to panel lengths and to the interval to be maintained between retreating panel faces.

3. The bleeder system should be incorporated in the overall ventilation plan. In many instances, it is realized only after a sizable gob area has been established that the projected ventilation requirements did not include sufficient pressure to provide an effective bleeder system.

4. Finally, strict supervision and a rigid schedule of inspection must be employed to maintain effective bleeding.

Recent Experiments in Degasification of the Pittsburgh Coal Seam in Northern West Virginia, William A. Light, project engineer, Humphrey No. 7 mine, Christopher Coal Co., Osage, W. Va.

Water-infusion is a process of injecting water under pressure into a coal seam to force out methane. The procedure includes (1) drilling 2-in holes into the face area, (2) setting an infusion plug and pumping the water in through a ¾-in hose, (3) pressure gages and water meter are used as control elements, (4) aniline dyes are added in some instances to provide a tracer and (5) wetting agents are sometimes used in the water to promote penetration.

Among the conclusions reached are:

1. Methane pushed out by water infusion is seemingly proportional to the amount already being liberated; that is,

methane pushed out in a section having a high rate of liberation is greater percentagewise that in one having a low liberation rate.

2. Volumes of methane in the order of 875,000 cu ft per 24 hr could be safely removed from a section during idle periods.

3. Methane liberated during subsequent mining is lessened, but not entirely eradicated. This residual methane may be that which is held within the intermolecular structure of the coal.

4. There seem to be no adverse effects on roof or pavements due to water infusion.

Fluidized Rockdusting

Improved Method of Rockdust Distribution in Face Areas and Bulk Handling of Rockdust, George L. Alston, product line manager, Mine Safety Appliances Co., Pittsburgh, Pa.

In the past it was economical to distribute small quantities of rock dust in paper bags to each working place. The dust would be applied by hand or by rock dust distributor. Today with the highly concentrated mining sections the quantity of dust delivered to each section has become such that it is no longer economical to handle the dust in the paper bags. It is known that rock dust can be purchased from $1.50 to $2.00 per ton cheaper in bulk than in bags. We also know that as much as 20% of the rock dust taken into the mine is never applied where it will afford any protection due to bag breakage encountered in handling the dust.

"For the past two years we have been experimenting with large hopper capacity distributors and have perfected a system whereby we can cause the dust to flow down a 6 deg slope which compares to the 60 deg slope in present distributors. With this new system we can now build track mounted distributors with a 20,000-lb hopper capacity and face area machines with a 4,000-lb capacity. We are also able to bring dust in bulk into the mine in special mine cars and transfer it directly into the face area distributors at the rate of 1,000 lb per min. With this new system rock dust can now be purchased in bulk and the manual labor of moving sacks of rock dust can be completely eliminated.

"Once we perfected the method of fluidizing the dust and increasing the hopper capacity more than tenfold, it was quite obvious that the next step would be to eliminate bagged rock dust completely and move the dust all the way from the quarry to the rock dust distributor in bulk."

Formal Discussion, C. William Parisi, director of safety, Pittsburgh Coal Co., Library, Pa. (Presented by Ewalt Herzog, safety director, Hanna Coal Co., Cadiz, Ohio).

"For a long time our company has been interested in the development of a more economical method of machine dusting. With the development of the 'airslide rock dust distributor' we feel that the first big step has been taken to correct what we consider an inefficient method of applying rock dust.

"We acquired a type S. C. airslide rock dust distributor several months ago and it was placed into operation at this mine. Although it has been in use for only a short time, the results have been encouraging. The hopper of the airslide distributor will hold 3,200 lb of rock dust and the machine is capable of discharging approximately 600 lb per min. At present two men are used to load the airslide machine into a shuttle car. This can be done in approximately five min. The cable is connected to the power take-off on the shuttle car and the starting box is placed where it can be safely and conveniently controlled by the operator of the shuttle car. The shuttle car is then trammed to the rock dust supply truck where two men will empty 40 bags directly into the hopper of the distributor. One man operates the shuttle car and the rock dust distributor. While the entries are being dusted the helper moves line brattice to enable the rock dust to cover the rib. When the hopper is emptied, the shuttle car returns for a refill."

Mine Fires

Metal Mines Fires: Organization and Equipment, Herbert A. Wendel, chairman, Bureau of Safety, Anaconda Co., Butte, Mont.

Fire in a metal mine is an ever-present menace, as it is in any type of underground mining, especially where a large amount of timber is required for structures or ground support and/or where considerable electrical equipment is used. Metal mine fires, however, are usually different from coal min fires or explosions in the respect that metal mine fires are often of greater extent and may involve greater property and production losses, despite the usually lower loss of life.

Use of High Expansion Foam Plugs, Bernard W. Carey, assistant superintendent, Odanah Iron Co., Hurley, Wis.

In most of the fire tests conducted by the Bureau of Mines, they found that the foam would not completely extinguish a fire but would effectively control it. By their definition this meant to quench the flames and reduce the temperature to a point where the fire could be fought directly and without protective clothing.

The foam plug technique should not be considered a primary fire fighting method. Ordinarily the best way to fight fire is by direct attack with water or chemical extinguishers. However, for one reason or another, this may not be possible. If the foam plug technique is properly and quickly applied to a fire as soon as it is determined that direct attack is not effective, many major fires can be averted.

Planning and Research

Value of Applying Safety Thinking Into Planning and Production, H. E. Mauck, vice president—operations, Freeman Coal Mining Corp., Chicago, Ill.

Protection of the industry's minimum manpower is perhaps the primary reason for giving diligent thought to safety in planning production activities. The economic situation today does not permit carrying extra men on the payroll to fill in when someone is hurt or absent. Planning must be done so that there is minimum reason for men to be absent. This is why safety planning is so significant. Every accident prevented means less man-days lost. Fewer lost days results in a more sound and stable operation.

A good example of planning for safety is seen in the newer covered man cars for transporting men to working places. Men in open cars were sitting ducks, and their own safety was not under their individual control. Similarly, automatic elevators are a boon to safety because the start and stop buttons are with the men on the cage. Furthermore, the cages are closed.

Experiences With Fire-Resistant Hydraulic Fluid at Harwick Mine, J. A. Younkins, assistant general superintendent, and M. E. Fowler, safety engineer, Coal Dept., Duquesne Light Co., Pittsburgh, Pa.

In January, 1958, arrangements were made with Shell Oil Co. for a trial installation of a water-in-oil emulsion designated as Shell 3XF Mine Fluid. It was installed in a 5-SC shuttle car and has been in continuous use to date. Later it was applied to a continuous miner and a loading machine in the same section and has been in use continuously.

The emulsion is mixed at the mine, the concentrate is purchased in bulk at 98c per gal. This is mixed with 40% of city water, resulting in a price of 58c for the fluid. The concentrate does not require inside storage, and the resulting emulsion with water is extremely stable.

The fluid runs at a lower temperature than oil. Replacement of parts on machines using the new fluid has been comparable with those using oil. Consumption of fluid is comparable with that of oil. Difference in cost figures out to 1.1c per ton more for the fluid than for oil.

No filters other than the cuno-metal leaf-type filters originally installed by the manufacturer were used in tests.

Bucket built 2½ tons



15% increase in capacity—14% weight reduction in this USS "T-1" Steel 15-yard dragline bucket for India.

This mark tells you a product is made of modern, dependable Steels.

lighter with USS "T-1" Steel

A new 15-cubic-yard Page AUTOMATIC Dragline Bucket for service in India makes maximum use of USS "T-1" Constructional Alloy Steel that cuts dead weight, increases capacity and boosts service life as much as five times. Designers increased capacity of this bucket 15%. Ten tons of USS "T-1" Steel were used in the bucket in plate thicknesses of 2¼", ¾", ⅝" and ½".

"T-1" Steel bucket yields 20 months' continuous service for DeLauter Coal Company. Mr. Roy DeLauter, Superintendent of DeLauter Coal reports, "Our Page AUTOMATIC Dragline Bucket, made of "T-1" Steel, has worked 24 hours a day, continuously for 20 months, stripping earth and lime rock from our seam which is buried some 80 feet in the ground. We've never had, heard of, or seen another bucket like it. It has given us five times as much trouble-free service as any other kind of material on the market. Why, during these 20 months, this bucket was never off the rig! And it's practically unheard of to run a stripping machine without a spare bucket. Yet we neither had a spare nor ever needed one."

In addition to this performance by USS "T-1" Steel at the 100,000 psi yield strength level for shovel booms, dozer blades, trailer bodies and mine cars, United States Steel also offers three other grades of steel at the 50,000 psi yield point level.

Depending on the economics and design involved, USS MAN-TEN, COR-TEN, and TRI-TEN brands of High Strength Steel also offer lighter weight construction with lower costs. USS MAN-TEN Steel features increased strength with high abrasion resistance for bolted or riveted construction. USS COR-TEN Steel is noted for higher strength with superior resistance to atmospheric corrosion. USS TRI-TEN offers strength and toughness with excellent weldability.

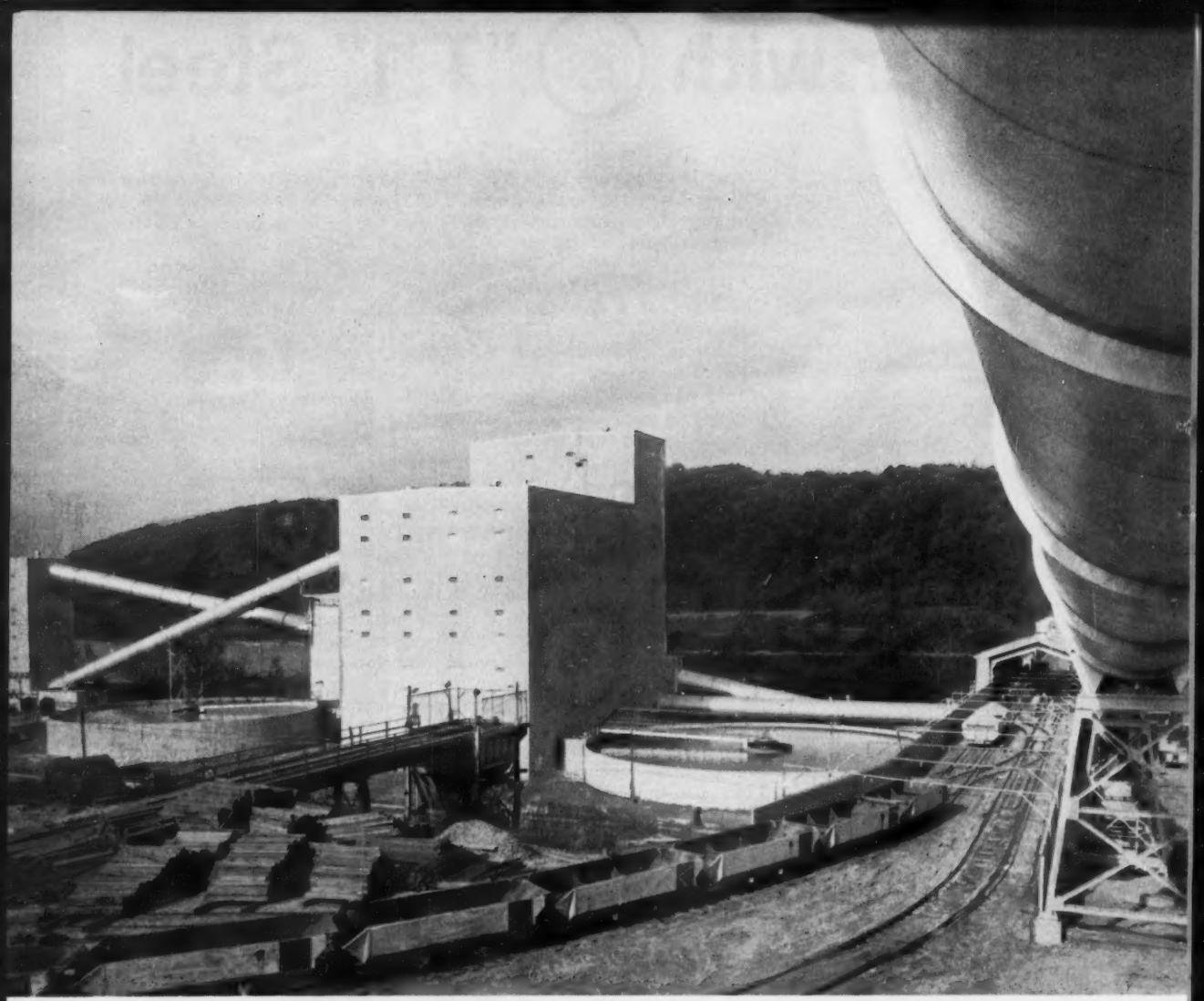
For long-life screens, USS Stainless Steel can't be beat. For more information on these special steels, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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Five times more life from this 7-yard USS "T-1" Steel bucket used by DeLauter Coal Company in Ohio.



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U. S. STEEL'S *New Maple Creek* PLANT··

The last word in modern architectural design for heavy industry. Special sheathing abates noise. Prefabricated, tubular conveyor galleries, the first in use, permit longer spans.

TRIPPER BELT distributes coal automatically to 72 pockets of blending bin in programmed checkerboard pattern.

COARSE-COAL WASHING is handled by 18-ft.-diameter sand-flotation cone receiving 5x¼ feed from 42-in belt.

INCOMING COAL from five up-river mines arrives in six-barge tows, is transferred to 400-ton bin by barge unloader at the rate of 560 tph.

MAIN CONTROL CENTER is located beside sand-flotation cone. Panelboard has ammeters that show loads on units.

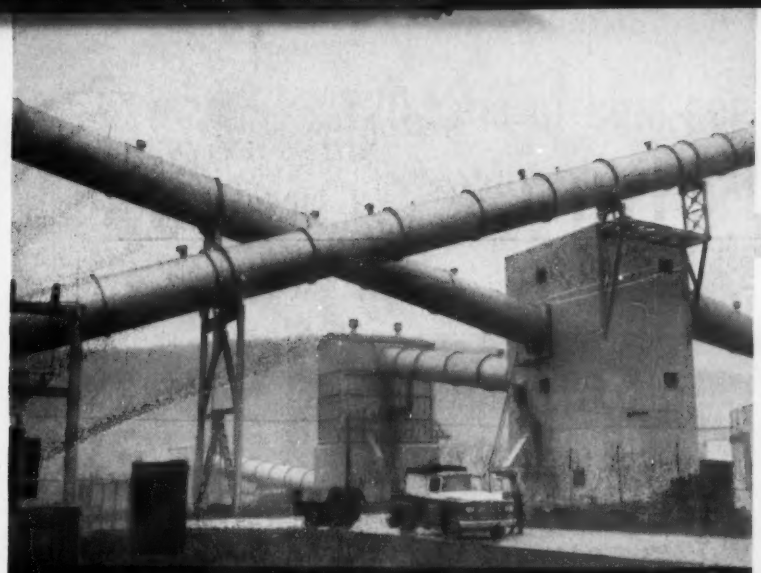
WET TABLES separate coal and rock from desilted fine feed delivered by four 6-way distributors.

THICKENERS are important in the flotation circuit. A 120-ft. unit concentrates raw feed and a 140-ft. unit thickens tailings.

VACUUM FILTER removes water from extreme fines before they drop onto clean-coal belt leading to transfer house.

REFUSE DISPOSAL AREA is 3.2 mi. from preparation plant. Rock is hoisted to surface by two 6.6-ton skips.

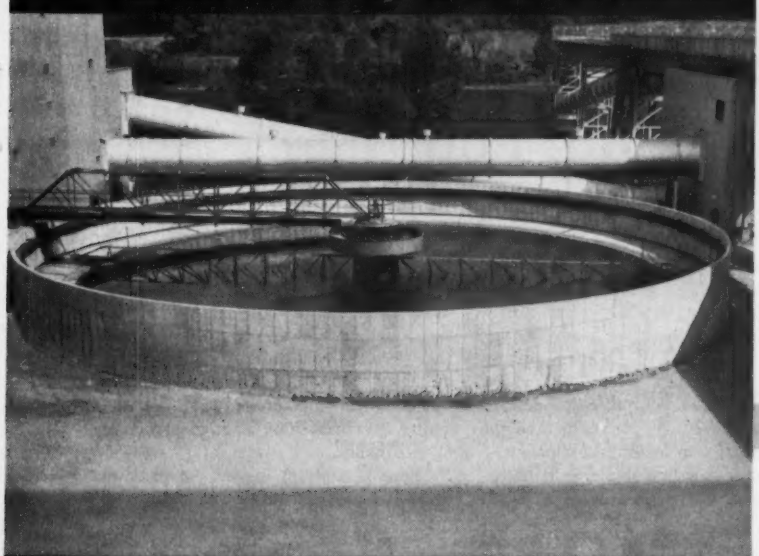
MAPLE CREEK PROPERTY includes 17,000 acres along the Monongahela River. Headings of old mine had to be rehabilitated to reach main body of coal.



TUBULAR conveyor galleries, first in any industry, were fabricated in 40-ft. sections for assembly at the plant. Sections are 10 and 11 ft. 3" in diameter.



OUTGOING COAL is fed to barge through telescopic chute. Barge payload is calculated by the displacement method. Coal goes down river to Clairton works.



RAKES pull concentrated solids from bottom of bowl desiltor which removes 100-mesh fines from table feed. Plant has two 44-ft. diameter desiltors.

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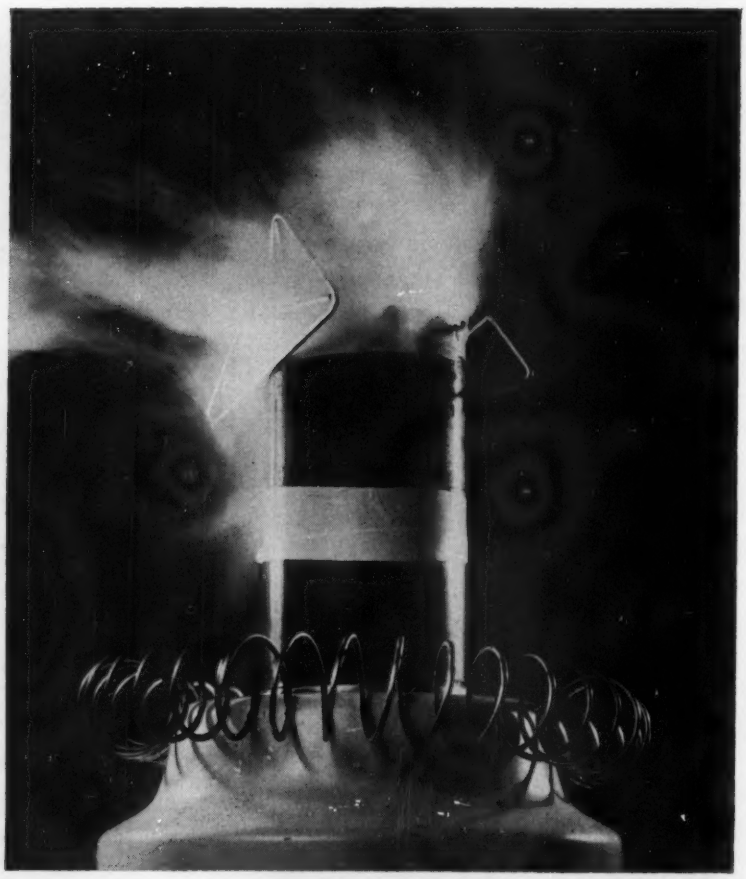
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Foremen's Forum



"Your petitioner . . . prays that letters patent may be granted to him for the improvement in . . ."

The Patent Office and You

IF YOU HAVE AN IDEA in your head that you think has commercial possibilities, the United States Patent Office after thorough examination of your claims of novelty and usefulness will grant you "letters patent." This means that the Patent Office acting for the Government, grants the right of an inventor to exclude others from making, using or selling his invention. This exclusive right is granted for a term of 17 yr, after which anyone can make, use or sell the invention.

The foregoing is the core of patent procedures, which have been written through enactments of Congress to promote the progress of science and useful arts. However, if your idea is one that really burns, you will want to take the first practical step leading to a patent.

We think your first step should be the engagement of the services of a patent attorney. Be sure he is registered by the patent office to practice in these matters. The patent office publishes a list of registered attorneys, or you may find their services listed in the "yellow pages" of the telephone directory. You call him up, make an appointment and talk the matter over with him. Your idea then is in safe hands.

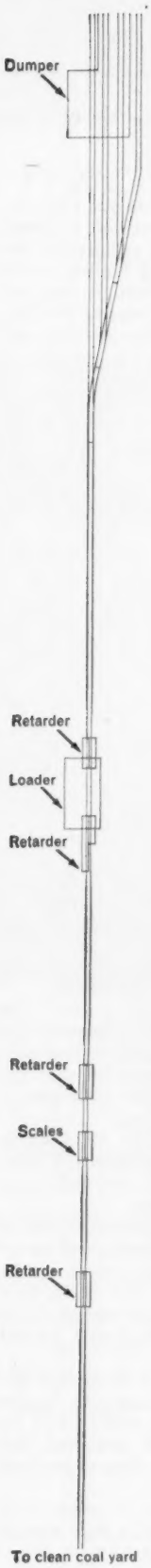
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720 tons of coal per hour loaded safely with Union Switch & Signal Car Retarder System

At U. S. Steel's coal cleaning plant, Corbin, Kentucky, a system of four car retarders is used to direct coal cars through loading, weighing and coupling operations. This Union Switch & Signal Car Retarder System places cars with speed and accuracy, eliminates a safety hazard and results in a substantial operating saving.

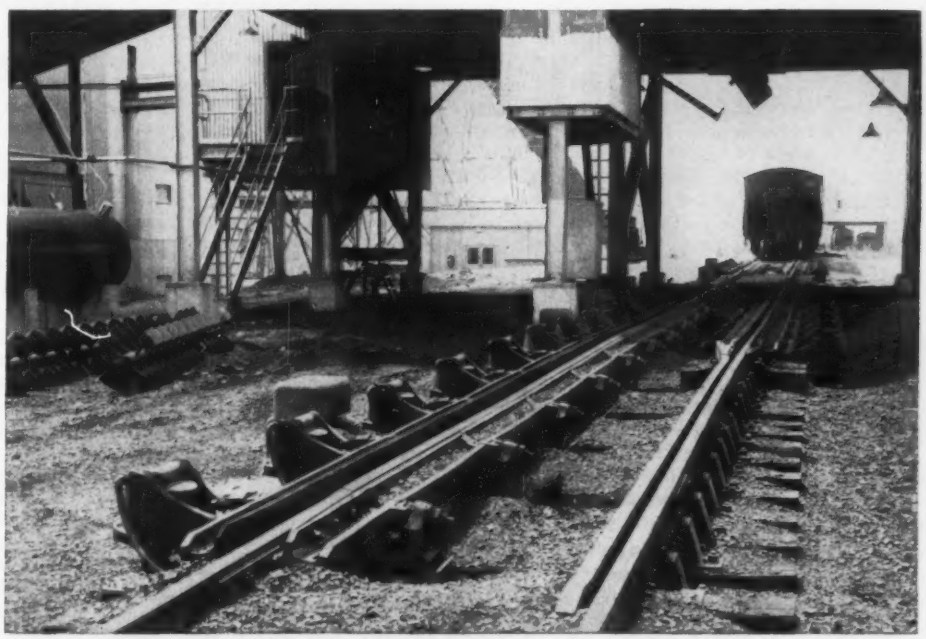
Empty cars are moved to the loading track where the pushbutton-controlled retarders take over while the cars are loaded. Cars next run by gravity to the retarders at the scale house, are weighed and then run by gravity to a collecting point at another retarder. The entire job is handled quickly and economically by two operators. In three years of operation, the system has been trouble-free and maintenance-free.

Let us help solve your car control problems. We will be happy to discuss with you—without obligation on your part—how a Union Switch & Signal Car Retarder System can speed up operations, promote efficiency, reduce safety hazards. Write today for more complete information.



The first retarder receives and controls empty cars before the loading. Under the loader the cars are slowed down by the second retarder, then move gradually to receive an even load distribution. The third retarder slows the loaded cars for accurate weighing. Just before the coupling, the cars are brought to a complete stop by the fourth retarder.

Empty cars moving to loader are controlled by first retarder, in background. This retarder arrangement provides for availability of 8 empty cars in advance of loading point. As loading progresses, second retarder, in foreground, controls movement of cars being loaded. This system of car handling moves cars with accuracy, assures a full, evenly distributed load.



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idea through the Patent Office, that is, without the services of a patent attorney. But he will be well worth his fee because he will help you prepare your application and claims with the goal of achieving maximum protection.

The Patent Office maintains precise standards on the manner and form of filing a patent application. The advice of a patent attorney will be helpful in this. Otherwise, you may find yourself involved in a large amount of technical correspondence with the Patent Office. When you engage the services of a patent attorney you give him a "power of attorney" to act for you in all matters pertaining to the patent proceedings. You do retain the right to revoke this authorization.

Searching the files

The Scientific Library of the Patent Office at Washington maintains a search room for the benefit of the public. It contains a classified set of all patents granted by the United States since 1836. You or your attorney can make a preliminary search here to determine whether your idea has been patented by someone else. This step can be taken before a formal application for letters patent is made. The Patent Office cannot respond to queries on the patentability or novelty of an idea in advance of the filing of an application. Nor is the Patent Office set up to expound or explain patent laws nor to act as counsellors to individuals.

The machinery of the Patent Office goes to work when your formal application for a patent is received. The examination begins. This examination of your application includes a more thorough search of the patent files by a government patent examiner. It is an exhaustive examination to determine that your application complies with all rules and statutes and to establish the novelty and usefulness of your invention.

The action

Following the examination the applicant's attorney is notified in writing of the examiner's decision. If the patent is granted, that's fine. If the decision is adverse, the examiner will explain his reasons to aid the applicant in deciding whether continued pursuit of the patent is worthwhile.

If you disagree with the examiner's findings you have an allotted time in which to reply in writing, pointing out where you think the examiner has erred. Be guided by your patent attorney in these proceedings. About four patents are granted out of every seven applications filed. We hope yours is one of the four.

After the patent

Your patent is your personal property. You can sell it, mortgage it or bequeath it to your heirs. There is one precaution. If your invention was developed on your employer's time using company tools or facilities, your employer has certain rights involved in the patent. Straighten out these matters with your employer before you file your application.

You can sell or transfer your patent by executing an instrument in writing. You can transfer the application for a patent in the same manner. The terms of sale or transfer are a matter of negotiation and contract between you and the buyer of the patent.

In the monthly column in *Coal Age*, entitled "Current Coal Patents" by Oliver S. North, you will often see that the patent is granted to an individual and "assigned" to a company. Usually the company is the employer of the inventor, and the assignment is agreed upon by the inventor and the company. Money may or may not change hands. This is the inventor's personal affair. Incidentally, only the inventor himself may secure a patent. No one can do it for him.

What a patent is

Your patent will grant you the right to exclude others from making, using or selling the invention without your expressed permission. The wording of the patent grant is important. It does not specifically grant you the right to make, use or sell the invention—if in the exercise of that right you run afoul of the law.

The fees are quite reasonable. You pay to the Patent Office a filing fee of $30 with your application and a final fee of $30 when the patent is granted. Your attorney's fee is extra. The patent office has a set of fixed charges for other services.

If you really think you have a patentable idea, we suggest you write for a copy of a booklet entitled "General Information Concerning Patents," available from Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., at 15c per copy. You will find it very useful and informative.

Emergency Planning

A RECENT ISSUE of *The Safe Mine Foreman*, a publication of the accident prevention department, Coal Division, Eastern Gas & Fuel Associates, carries a 9-point program of emergency action when smoke is encountered in working sections. The recommendations were written by Andrew J. Sleboda, plant inspector, Wharton No. 2 mine, and apply primarily to local conditions at Wharton No. 2. However, they can serve as a model for similar specifications at your mine, with due regard for local differences.

Here are Mr. Sleboda's nine points:

1 When smoke is detected on your section from an unknown source, someone should be immediately sent down the return airway to open as many man-doors in the stoppings as possible between the intake entry and the belt entry. Break down a stopping if necessary.

2 Notify the dispatcher immediately so that he can send help quickly and take steps to locate the fire and its extent to combat it. Keep in touch with him as much as possible during the emergency.

3 Temporary check curtains should be erected immediately across all entries so that the smoke will be deflected. While this is being done the Self-Rescuers in the firebox should be distributed to the crew for protection, if necessary.

4 After the curtains are erected barricades should be built immediately.

5 Do not leave your section in an emergency unless you are positive that you can make it safely to the outside. If you leave the section, be sure that you have a Self-Rescuer with you. It could save your life.

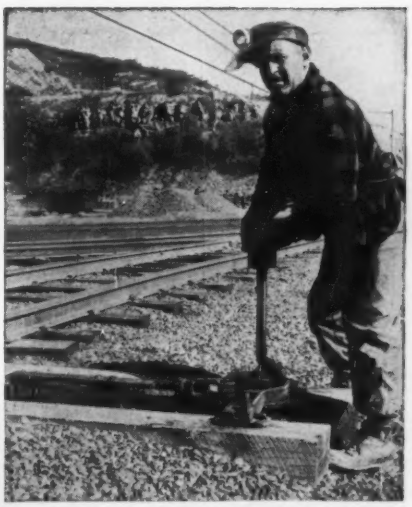
6 Keep in mind that we have an excellent mine-rescue team at this mine. If you are barricaded, they will reach you as soon as possible.

7 There are numerous escapeways in this mine. We have three slated entries in all parts of the mine which can be traveled very quickly and easily. Each foreman is requested to explain to his crew in full detail where they are and how to reach them.

8 On your bulletin board is a barricading plan. It is suggested that the foreman at this safety meeting read the 12 steps so that all concerned will have a better understanding of barricading.

9 When you have a smoke emergency, take the protective steps immediately. Delay can be fatal.

Bring your trackwork problems to Bethlehem



SWITCH STANDS, such as the Model 1222, are a Bethlehem specialty. The 1222 is shown here in use with 85-lb rail. Notice how low and compact it is—over-all height is only 4¼ inches! The only moving parts are lever, crank, and sliding block—no maintenance worries there!



SPECIAL TRACKWORK like this can be designed, built and completely preassembled at our plant to be sure of perfect fitting at your site. The "Bethlehem approach" to your layout problem costs no more initially, and pays for itself in the long run.

A smooth, well-built haulage system is the backbone of efficient mining. That's why we urge you to bring your trackwork problems to Bethlehem. We have had long experience in the manufacture of rails and accessories, and this is backed up by operating know-how acquired in our own mines. We have the facilities and engineering to help you improve your transportation efficiency.

A Bethlehem engineer is ready right now to pay you a visit and talk over your needs with you. Why not call our nearest district office and arrange a get-together?



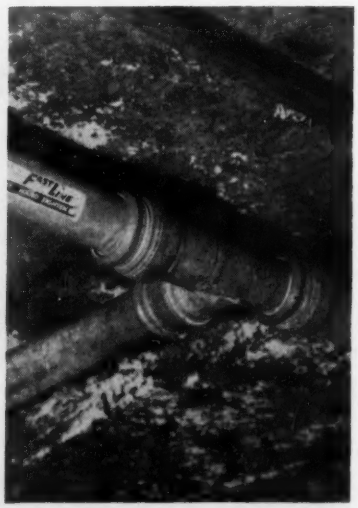
SWITCH HEEL BLOCK Design 992 was developed by Bethlehem especially for use with mine turnouts. It helps maintain heel spread and track gage at heel end of switch, keeps closure rail and switch point properly aligned. Bolts can be drawn up tight without hindering the lateral movement of switch points.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Operating Ideas





New Lightweight Pipe Saves Time and Labor

A NEW, quick-coupling, lightweight galvanized steel pipe is saving time and money for Crucible mine, Crucible Steel Co., Crucible, Pa. This line, which is suspended from the mine roof, supplies compressed air at 120 psi to machines working at the face.

More than 12,000 ft are used at Crucible and the McDowell Fast-Line pipe installation has proved its value many times. According to Frank Burns, mine superintendent, the Fast-Line's quick installation and easy dismantling saves his men valuable time moving from one location to another and moving ahead at the face. The net result is greater productivity per day.

The Fast-Line connections are made in 10 to 15 sec and are leakproof because of a built-in neoprene gasket as well as positive pressure from the union-type coupling. Making the connection is as easy as connecting an ordinary garden hose.

One man can carry a 30-ft section of the pipe easily since it weighs only 40 lb. The integrally attached couplings eliminate coupling displacement, possible loss and the extra handling which are common with loose parts. They also provide heavy-duty pipe end protection for the lightweight steel pipe.

Adding to the flexibility and convenience of the pipe are supplementary couplings which permit branch line take-offs, sharp-radius curves and the following of natural contours for irregularities in the roof.

The pipe is re-usable. It can be uncoupled as quickly and easily as it is assembled, merely by hand loosening the coupling locknut. Although light in weight, the pipe has considerable strength. Both pipe and couplings are designed to operate at working pressures up to 600 psi, with a bursting pressure of 1,800 psi.

Although the cost is a few pennies more per foot than standard pipe, savings between 66 and 80% have been reported in installation and labor time in the field. The pipe is fabricated from galvanized sheet steel and the steel couplings are mill-attached to the pipe ends. The couplings as well as the steel pipes are protected against corrosion by a zinc coating.

How to Prevent Engine Overheating

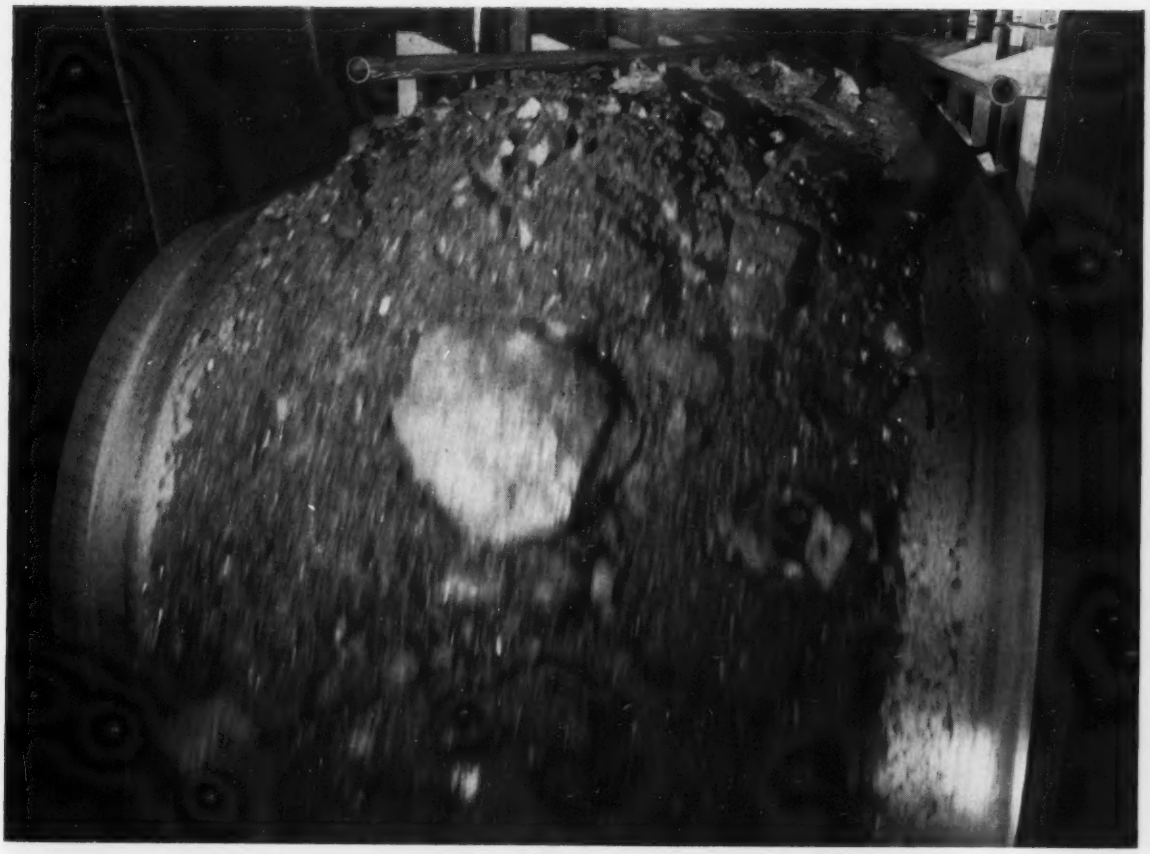
OVERHEATING of engines becomes most serious in summer, when heat and dust put additional loads on cooling systems. Vehicles traveling on dusty terrain are especially subject to overheating. Overheating may result from restricted flow of air, restricted flow of water, or reduced transfer of heat from water to air. The following suggestions, adapted from *The Co-Operator,* published by LeTourneau-Westinghouse, may be helpful in preventing engine overheating at your operation.

Cleaning Water Passages

Assuming the engine water is at the correct level, one of the first things to check in case of overheating is the external condition of the radiator. The outside of the radiator should be cleaned whenever the dust deposit is sufficient to hinder the flow of air or transfer of heat to the air. In extremely hot weather special care should be taken to keep it clean.

An air hose with a nozzle may be sufficient to remove loose dust from the radiator core. Occasionally, oil may be present and require the use of a solvent to loosen the dirt. Petroleum solvents, such as kerosene or fuel oil, or a mild alkaline cleaning solution are suitable. Gasoline or spirits are efficient solvents but present a fire hazard.

With blower-type fans, which suck air from over the engine and blow it over the radiator, solvents may be applied by pouring them into the air stream at the fan with the engine operating. With the engine stopped a spray gun can be used effectively to apply solvents. After applying the solvents, use air to remove any remaining dirt. Repeat as necessary.



For 'round-the-clock service in giant Moss No. 3 Mine...

CLINCHFIELD SPECIFIES BELTING OF TOUGH, FIRE-RESISTANT NEOPRENE

At one of the world's largest, most completely automated mines—Clinchfield Coal Company's Moss No. 3, at Duty, Va.—neoprene conveyor belting has been specified *exclusively* in all four portals. Currently operating 16 hours a day, Moss 3 employs over 12 miles of neoprene-protected conveyors and feeders to haul 1500 tons of raw coal per hour.

Neoprene belting was specified for two very important reasons: *safety* and *economy*. Neoprene is fire-resistant and will not support combustion. Its *balanced* combination of properties affords long-term savings, low maintenance and dependable performance under rugged mining conditions.

Neoprene has a high coefficient of friction. Consequently, belt "run-out" is at a minimum at loading points and on mine-to-surface conveyors. Highly resistant to abrasion, cutting and chipping, neoprene also helps to protect against fabric deterioration from oil and grease, acid mine water and mildew. Above ground or below, neoprene's resistance to weather, aging and temperature extremes is further assurance of long belt life.

Specify *neoprene* belting the next time you buy—or replace—conveyor belting. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department CA-7, Wilmington 98, Delaware.

DU PONT
REG. U. S. PAT. OFF.

NEOPRENE
SYNTHETIC RUBBER

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Rinse the radiator with clean water.

Where facilities are available, the steam jet is preferred for cleaning radiators. If dirt is caked, it may be necessary to apply a solvent before the jet is used.

Cleaning Air Passages

Scale deposit inside radiators results from the effect of heat on minerals in the cooling water. This scale coating reduces the transfer of heat. Instead of forming scale, some waters also produce a silt-like deposit that restricts water flow and therefore must be flushed out. Flushing should be done at least twice yearly.

To remove scale, chemical action is necessary. A flushing compound, such as sal ammoniac (¼ lb per gallon of radiator capacity) should be added to the cooling water in the form of a solution with the engine running. Operate the engine for about 15 min then drain and flush with clean water. Other flushing compounds are commercially available. Most compounds attack metals and should not remain in engines for more than a few minutes.

For obstinate coatings, such as lime scale, strong solutions are sometimes necessary but they are dangerous. Remember that the metal in an efficient radiator core is extremely thin and offers little resistance to acids.

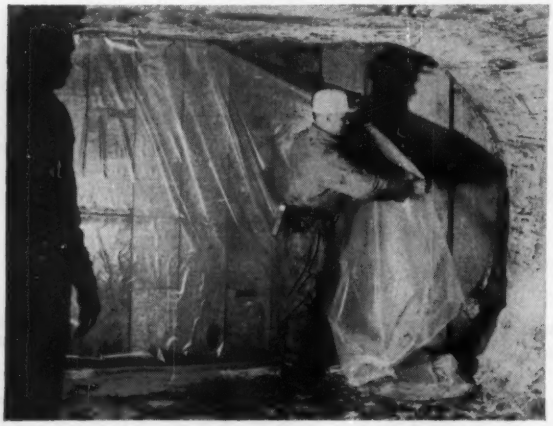
Other Causes of Overheating

Overheating also may be caused by recirculation of air through the radiator. This condition occurs when the hot air from the radiator passes around the sides or bottom of the radiator and is again forced through the radiator by the fan. The fan shroud must be fitted tightly to prevent recirculation and to ensure maximum effieciency from the air blast.

On units with belt-driven fans, belt slippage is a common cause of overheating. Fan-belt slippage is caused by such things as pulley-groove wear, belts of unequal length when two or more belts are used, incorrect belt tension or a worn fan belt.

Leaks in the cooling system should be found and eliminated whenever loss of water causes overheating. If the thermostat is damaged, it may not open fully thereby restricting the flow of water and resulting in overheating. In this case the thermostat must be replaced.

When repainting the radiator core, use a thin coat of dull black radiator paint, or some high quality radiator finish of the type known as "optical black." Ordinary oil paints have an undesirable glossy finish and do not transmit heat well.



Polyethylene Film Seals Mine Stoppings

ONE of the newest applications for polyethylene film, the versatile plastic which has found an ever increasing utility in many fields, is its use as a seal over stoppings in coal mines.

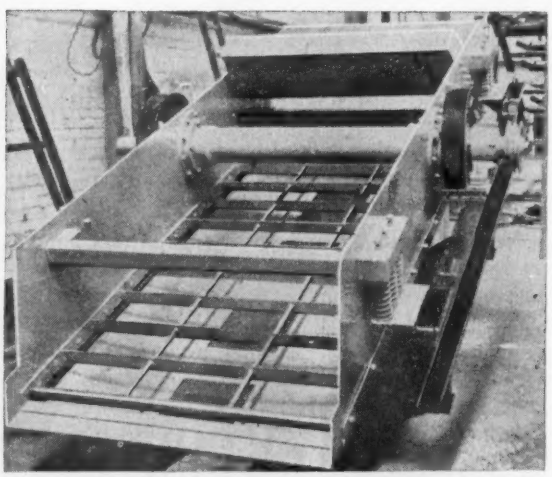
In its Robena No. 3 mine in Greensboro, Pa., U. S. Steel Corp. is experimentally trying 6-mil clear Durethene polyethylene film, a product of the Plastics Div., Koppers Co., Inc., to limit air leakage through metal stoppings. About 100 ft of the Durethene film is used to cover each stopping.

Piano-Wire Screen Has Greater Capacity

PIANO WIRE is an added starter as a screen surface for fine-coal sizing, according to *Iron & Coal Trades Review*, August 28, 1959. Because of its special construction, the manufacturer states, the piano-wire surface has a very much greater open section area than any other type of screen cloth. As a result, capacity is greater than normally expected.

Two identical vibrators installed side by side in a colliery and receiving common feed material showed the following results: one unit equipped with ⅛-in-wide aperature piano-wire screening surface handles an average input of 95 tph, removing fines at 25 tph; the second unit, equipped with 3/16-in square-aperature woven wire, handles an average feed of 45 tph and removes 10 tph of fines.

A specially designed mild-steel frame holds piano wire stretched end to end, each wire being individually tensioned by means of a separate peg in a tensioning board. A special key is provided for turning the pegs. A guard plate directs the feed away from the tensioning board. Transverse strips with accurately machined recessed guides support the wires



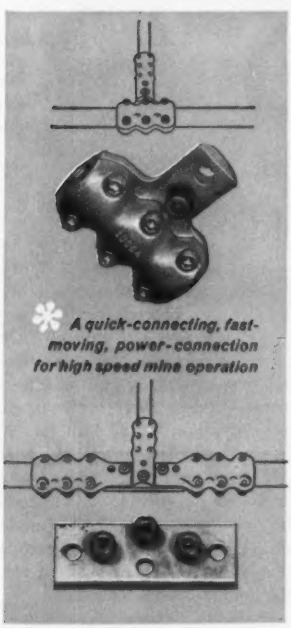
and when the wires are in tension the opening is rigidly maintained. Since each wire is individually installed, it is necessary to replace only one wire, should one break.

O-B Designs for Mining Men:



RESULT: you can make connections

between seven popular sizes of copper or aluminum cables . . . joining the same or different sizes . . . either copper or aluminum



A quick-connecting, fast-moving, power-connection for high speed mine operation

10050-M

FAST . . . The new O-B Cable Connector makes or breaks a cable connection simply with the turning of two cap screws. These sturdy fittings are especially designed for sections that are picked up and moved frequently.

VERSATILE . . . You can add or remove sections of cable to keep pace with fast machinery. You can make tap-offs, 3-way connections between cables, or a variety of switch and panel arrangements . . . all in minutes!

SIMPLE . . . Your O-B Cable Connectors give you the advantages of "built-in" cable connections that hook-up or disconnect simply. No specialist needed . . . saves time and labor on the job.

Write us . . . or see your local O-B sales-engineer to order the new O-B Cable Connectors. You'll find—as others have—that they make moving easier, faster, and considerably cheaper. OHIO BRASS COMPANY—MANSFIELD, OHIO, Canadian Ohio Brass Company, Ltd., Niagara Falls, Ontario.

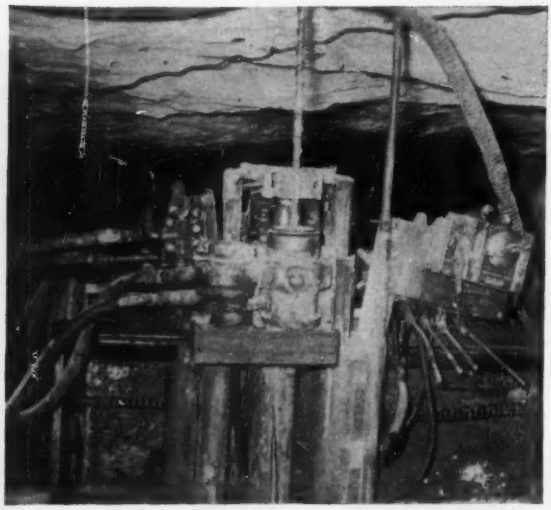
Ohio Brass

HOLAN

EXPANSION SHELLS AND PLUGS · LINE MATERIALS · SAFETY AND CONTROL EQUIPMENT · ELECTRIC HAULAGE MATERIALS

See listings of O-B sales officers and distributors in this issue.

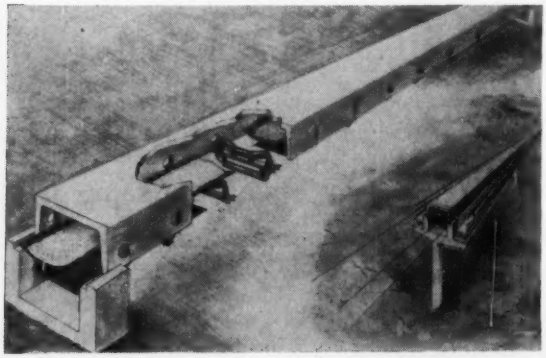
Equipment Developments



Faster Drilling

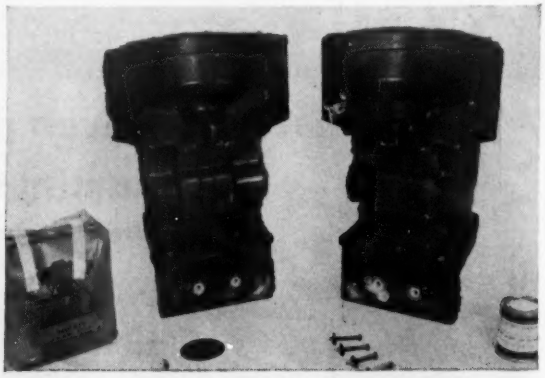
A newly-developed rotary percussion tool has been placed on the market by Impact Rotor Tool, Inc., Irwin, Pa. The tool can be used on rotary roof-control drilling machines, or continuous miners that are equipped with the rotary drilling set-up. The tool, especially designed for drilling hard rock formations, is placed on the present hydraulic rotary-drilling motor in a manner whereby the impacting action is not on the hydraulic-motor gears. The result is reduced maintenance costs. Users of "Impacto" are extending their bit life up to 200% and decreasing drilling time by 50%, according to the company. The J. H. Fletcher Co., Huntington, W. Va., is the distributor for the machines.





Building Conveyors

Use of prestressed concrete channels as conveyor support in a materials-handling system has been announced by The Frank J. Madison Co., San Francisco. U-shaped beams are inverted so as to also serve as a protective cover for the belt, drive, idler and material being handled. Lower initial cost is cited as the chief advantage of the prestressed construction. Inserts for idler attachments are integrally-cast in the channels, eliminating the need for steel hangers. Supporting piers and changeovers may be precast or cast-in-place, and no steel structurals are required. Comparative studies for the first installation, a 1½-mi conveyor at a large western industrial plant, indicated savings of 40% over conventional steel construction, declares the company. Maintenance costs are reportedly lowered by the concrete's inherent freedom from weathering and ease of servicing made possible by inspection ports at each idler.



Fast Rail Welding

A new method of rail welding, now being offered by Thermex Metallurgical, Inc., Lakehurst, N. J., provides a highly simplified means of welding by the Thermit process. Result of several years of development, the new self-preheat Thermit weld completely eliminates the time-consuming operation of preheating rail ends prior to welding, and, by making use of preformed factory-made molds, does away with the preparation of molds on the job, according to the firm. Materials are supplied in kits, each kit containing everything needed to make one weld in rail of a prescribed section. There are three steps: aligning the rail ends; applying the molds; and pouring in and igniting the welding compound. A completed weld can be made in from 5 to 6 min, declares the company. Thermex adds that a new method is fully developed for all standard rails up to and including 100-lb sections.

ROCK BOTTOM EXPLORATORY COSTS

RESULT IN REPEAT ORDERS TOTALING 11 UNITS FOR MID-WEST COLLIERY

REICHdrill T-400 supplies exploratory information fast

One of the largest, most efficient collieries in the Mid-West found that in exploratory drilling they could obtain a reading of overburden, rock strata, and coal measures in record time using the T-400 REICHdrill. This all-hydraulic top-drive rotary rig can drill up to 6″ diameter holes and can take cores from depths of more than 3,000 feet. And it moves from hole to hole fast and easy. Costs? Rock bottom!

So they repeat-ordered 10 more REICHdrills. Their operators like the T-400's exclusive lever-type mast construction. Applies full pressure of 10,000 pounds directly over rod and offers continuous 12-foot stroke.

Other REICHdrill features include: fast, easy adjustment of rotary speeds and down-pressure for optimum penetration and bit life in all formations . . . direct drive to drill stem that saves power loss . . . no complicated transmission, no rotary table, no kelly means in and out of the hole faster . . . instant safety torque release protects all drive components, saves rotary and diamond bits, core barrels, and drill steel.

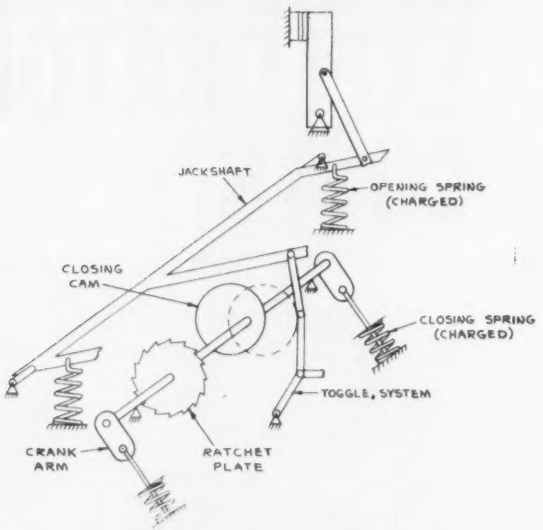


For further information write:

REICHdrill
HOWARD STREET, FRANKLIN, PENN.
Division: CHICAGO PNEUMATIC TOOL CO.

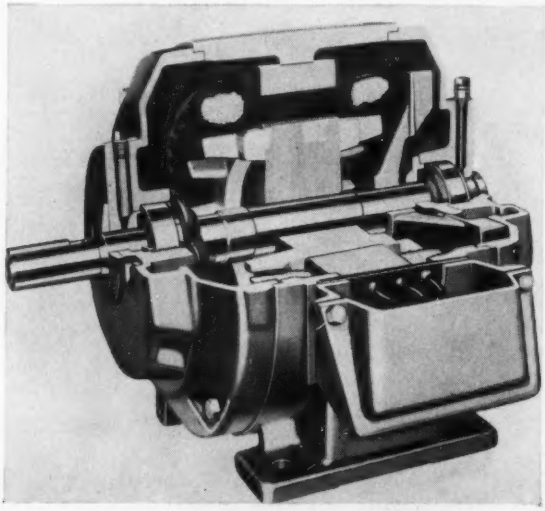
REICHdrill Model T-400 is truck-mounted, hydraulic-powered. 12-foot continuous stroke. Down pressure: 10,000 pounds. Water pump: 35 g.p.m. and 225 p.s.i.





Circuit Breakers

I-T-E Circuit Breaker Co., Philadelphia, now offers a completely new design of 4,160-V circuit breakers and switchgear featuring stored-energy closing and ironless blowout. These two features, said to be a first in this voltage rating, afford faster fault interruptions and faster closing of contacts and smaller size than any other comparable equipment available today in the 4,160-V field, declares the firm. Key feature, the stored-energy closing mechanism (above right), uses energy stored in powerful springs to close the breaker contacts. Charged through a ratchet and pawl system either manually or by a small AC motor, the springs are held in charged position by a set of latches. Releasing the latches—either through the manual firing lever, or by energizing a small closing coil—permits the springs to release their energy and, by operating on a toggle system, lift the jackshaft. Lifting the jackshaft not only closes the contacts but also charges the springs which open the contacts when the breaker receives the trip impulse. One result, besides faster closing of contacts, is far greater safety for personnel. Other features cited by I-T-E include compact size and low center of gravity, rigid construction, improved bus and wiring design and easy access to current transformers for making adjustments.



Weatherproof Motor

A new line of open weatherproof AC motors with an epoxy-encapsulated insulation system has been introduced by Reliance Electric & Engineering Co., Cleveland. The "Duty Master" motors are available in frames 180 to 445U, 1 to 125 hp, in all standard speeds and voltages. The stator windings are encapsulated in a special epoxy resin for resistance to moisture, oils, dust, chemicals, acids and other substances. The bearings, exposed internal metal surfaces, hardware and mechanical parts are also protected and rust-proofed. Besides a unique vacuum impregnation and pressure process, which uniformly coats the motor windings to permit excellent heat dissipation and high resistance, Reliance "metermatic" lubrication is employed with the deep-groove double-shielded ball bearings.



New Front-End Loader

Caterpillar Tractor Co., Peoria, Ill., is now producing the

B.F.Goodrich



50-ton loads of coal take a 5,000-hour ride on B.F.Goodrich tires

DAILY production at the Fiatt, Illinois, mine of the Truax-Traer Coal Co. is 7,300 tons. Coal is hauled to the tipple over roads made of crushed limestone. Loads average 50 tons—yet estimated service on the original tread of the B.F.Goodrich Rock Service tires is 5,000 hours!

New long-wear tire compounds

Now Rock Service tires are available in 2 new B.F.Goodrich compounds that tests show outperform any others on the market. Yet they *cost no more* than conventionally made tires. Cut Protected compound gives longer service where:

- Cutting and chipping are severe.
- Round-trip hauls are short.
- Trucks travel at low speeds.

Heat Resistant compound defies dangerous heat build-up where:

- Haul roads are well maintained.
- Trucks travel at high speeds.
- Cutting is negligible.

Intensive B.F.Goodrich research and testing went into the development of these compounds. Only B.F.Goodrich makes Cut Protected, Heat Resistant and Regular compound tires that are actually tailor-made for your type of work. Your B.F.Goodrich Smileage dealer will recommend the best one for you. He's listed under Tires in the Yellow Pages. *The B.F.Goodrich Company, Akron 18, O.*

Specify **B.F.Goodrich Tubeless or tube-type tires when ordering new equipment.**



Smileage!

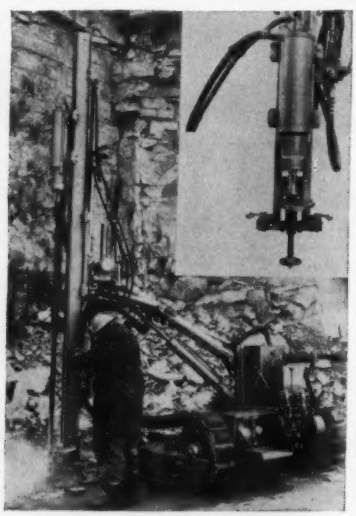
966 Traxcavator, second in a line of wheeled front-end loaders. Similar in design and machine configuration to the 944, the 966 is a 140-net hp unit with a 2¾-cu yd bucket as standard.

Outstanding machine features are the open cockpit, which permits easy accessibility from either side, and the location of all loader lift mechanism completely ahead of the compartment. Maximum lifting height is 154 in, with top reach of 35⅜ in. At ground level, there are 41 deg of bucket tiltback. The machine can give 24,000 lb breakout force. Turning radius measured at the outside rear tire is 20 ft 9 in, ground clearance 17½ in.

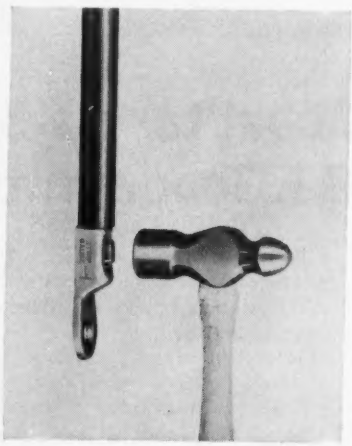


Rugged Tire

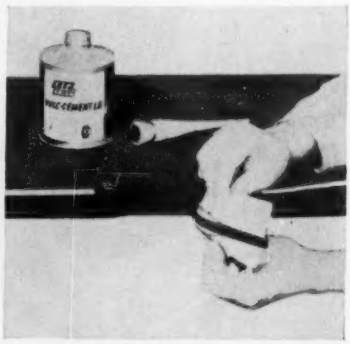
A new steel-reinforced tire designed to withstand the rugged conditions of lumbering, but also suitable for use in mining areas, has been announced by United States Rubber Co., New York 20. Under tests in the Pacific Northwest logging areas for 4 yr, the tire reduced tire failures by two-thirds as compared to conventionally-designed logging tires, according to the company. The steel reinforcement in the tire, called the U. S. Royal Fleetmaster Supper Logger S.R.T., consists of several thick layers of tread rubber containing many thousands of short lengths of brass-coated, hardened-steel filaments. These are closely interlaced, yet individually rubber insulated. They form a dense, protective mat between the tread, shoulder and buttress areas of the tire and its nylon-cord body. The new tire gives 70% more mileage than the previous U. S. Royal logging tire due to an improved rubber compound and a tread that is wider and 50% thicker than the old tread, and records show that many more of the new tires were retreadable than conventioanl logging tires, adds the firm.



DRILLING — The Trac-Newmatic, from Le Roi Div., Westinghouse Air Brake Co., Milwaukee 1, is designed for fast, economical drilling of vertical, horizontal and angular primary and secondary blast holes. There are two models. The LDC-500R, mounting a new striking-bar-type 5-in drifter, permits drilling of 4-in holes in as little time as normally required for 3½-in diameter drilling, says the firm. A similar-type 4-in drifter used on the LDC400R Trac-Newmatic is reportedly equally efficient for drilling requirements for 2½ to 3 in.



BETTER CONNECTIONS — A hammer is the only tool needed to make a perfect connection with "Red-E" lugs and splicers to welding and power cables, according to Bernard Welding Equipment Co., Chicago, Ill. The lugs and splicers eliminate special crimping tools, wrenches and soldering equipment. Red-E lugs and splicers are easily installed by merely inserting the stripped cable and then driving down a self-contained impact punch with an ordinary hammer. The connectors also feature large easy-to-read cable size markings and a handy stripping gage stamped on the side of each connector. They are available in full range of sizes from No. 6 to 1 and 1/0 to 4/0.



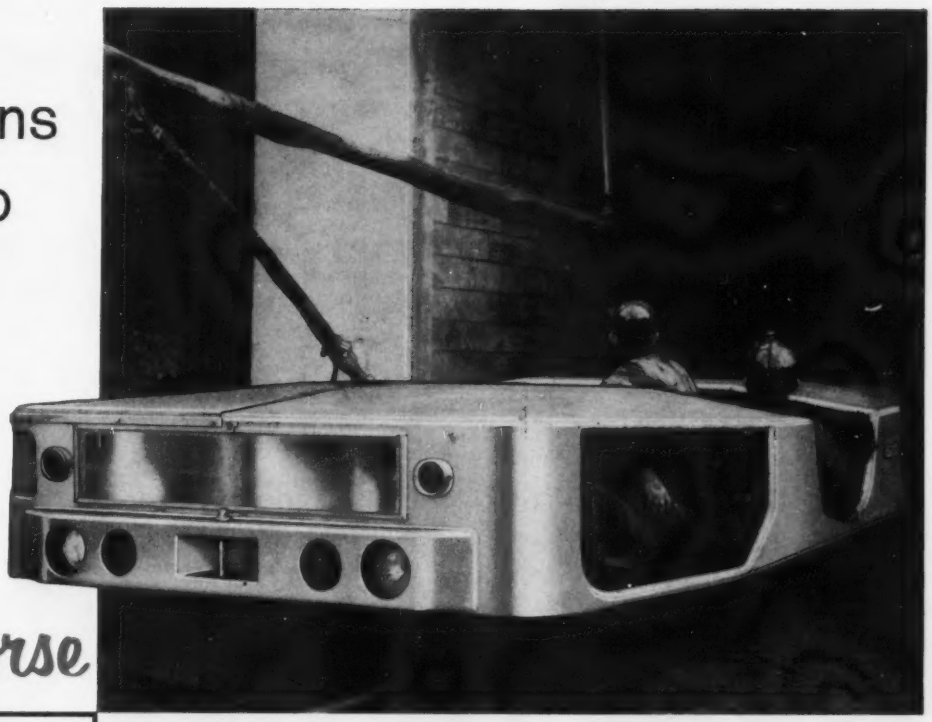
REPAIRING BELTS—Preformed edge repair cuffs, by Rema-Tech, Inc., New York 16, are the latest cold vulcanized repair materials for damaged or frayed conveyor belt edges, says the firm. Due to the simplicity of application, conveyor belt edges can now be repaired on the spot, like new, by any careful workman, without use of costly or heavy equipment, declares the company. The firm makes a complete line of cold vulcanizing repair materials including belt cleats, cover stock and patches.



BITS—Western Rock Bit Mfg. Co., Salt Lake City, Utah, developed two new "one-use bits" for dustless vacuum-type drills. The WRB "Tee Cee"-type TCVA or TCVB is a shallow tungsten-carbide insert bit for either class A or

Reasons why so many mines use the

Lee-Norse



LOW mine portal bus

1. FAST—Cuts portal to portal time as much as 50%.
2. STREAMLINED—Transports 11 to 13 men in safety and comfort in low seams.
3. SAFETY—Exclusive split-roof allows operator full directional vision—trolley pole easily reached. Quick acting hydraulic truck-type brakes on each axle and on the traction gearmotor. Independent mechanical hand parking brake each axle.
4. POWERFUL—Self-propelled by sturdy traction-type 15 HP gearmotor (250 or 550V—DC).
5. RUGGED—Quality built to withstand the hard usage of 'round the clock mining!
6. LOW MAINTENANCE—Simple design—easy accessibility.
7. OPTIONAL FEATURE—Electric dynamic brakes for plus safety on severe grades.



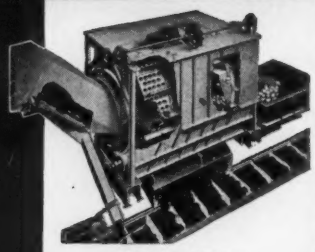
LN

Lee-Norse Company

CHARLEROI, PENNSYLVANIA

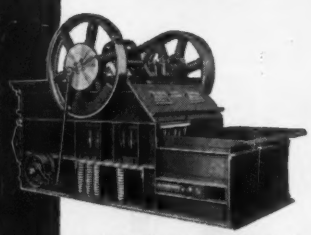
Specialists in Coal Mining Equipment

America's most complete line of CRUSHING EQUIPMENT



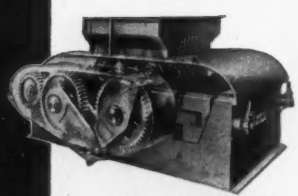
McNally Pittsburg Rotary Breaker

This unit allows positive control of top size in handling run-of-mine washery feed. Production of fines is held to a minimum.



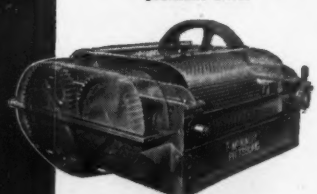
McNally Norton Vertical Pick Breaker

50% Less fines when reducing lump to egg and stove sizes.



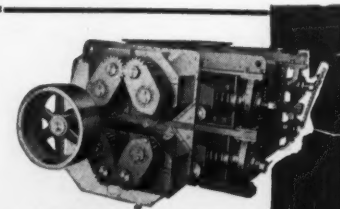
McNally Double Roll Gearmatic ROM Breaker

Built in tonnage ranges from 750 tph to 1400 tph. Full floating gearmatic drive.



McNally Gearmatic Stoker Coal Crusher

This unit offers three prime advantages: high volume production, plus accurate sizing, plus low percentage of fines.



McNally Two Stage Crusher

This unit consists of a double roll primary crusher mounted above a double roll secondary crusher—compactly arranged into a single rigid structure.

Available From Stock and on Short Delivery

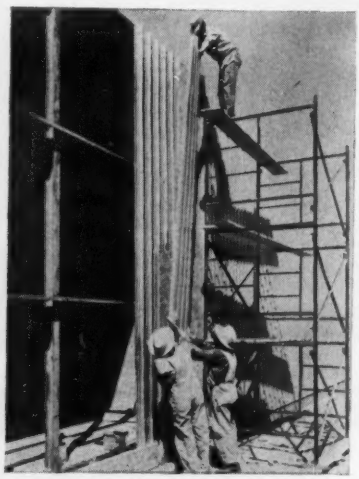
For immediate action on complete information write, wire or call

McNALLY PITTSBURG MFG. CORP.

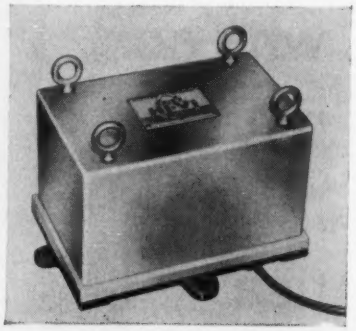
Pittsburg, Kansas Wellston, Ohio

Equipment News (*Continued*)

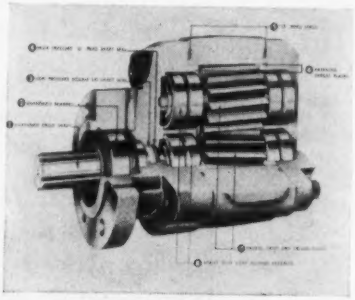
class B taper connections. This long-life heavy-duty tungsten carbide insert bit needs no resharpening, says Western. It was designed to provide operators with low-cost footage. The SLVA or SLVB bit is a low-cost "used to destruction" steel bit. Outstanding feature is its pilot construction and wing design. The pilot chips the rock ahead of the cross wings and eliminates the pulverizing action common to conventional cross bits. Both types of bits are of 5-hole design and are interchangeable.



LOW-COST PANELS – Insulated steel sidewall panels which are assembled in the field have been announced by the Truscon Div. of Republic Steel Corp., Youngstown, Ohio. The low-cost panels are made by sandwiching a layer of insulating material, such as fiberglas, between two sheets of Truscon 24-in "Ferrobord" or galvanized rubber siding. The panels come painted or galvanized in widths of 2 ft and up to 40 ft in length. Used for most types of industrial or commercial structural frame buildings, the panels' features, long length and absence of horizontal joints, offer savings in erection time and a neat trim surface, says the company.



LARGE VIBRATOR—The newest and largest unit in its line of bin vibrators has been announced by Eriez Mfg. Co., Erie 6, Pa. The new model, No. 60U, is an "in-line action" type of unit for installation on bin walls of about ⅜-in thickness and 20-ton capacity. The concentrated vibratory action is more independent of objects to which it is attached than competitive units and is more stable in operation over a wider range of service conditions, says Eriez. The unit is a double-impact type, impacting at both top and bottom of the stroke.



FLUID POWER PUMP – New fluid power pumps, Model H, Series 15, with constant volume output in five sizes—from 24 rpm at 1,200 rpm, has been announced by Commercial Shearing & Stamping Co., Youngstown, Ohio. Rated for continuous-duty operation at pressures up to 2,000 psi and speeds to 2,400 rpm, the small 15-H "powerhouse" is designed for applications where flow requirements are less than for Commercial's larger Series 36H line. The 15H comes in ½-, ¾-, 1-, 1¼-, 1½-, 1¾ and 2-in widths. A key feature is "built-in" perfect alignment made possible through basic construction which entails machining all internal parts from one common reference, the gear center line, says the firm. Result, says the firm, is that gear bearings act as dowels, eliminating outmoded dowel pins.

SELECT THE CABLE MADE BY THE FAMOUS "MINE-TO-MARKET" FAMILY . . .



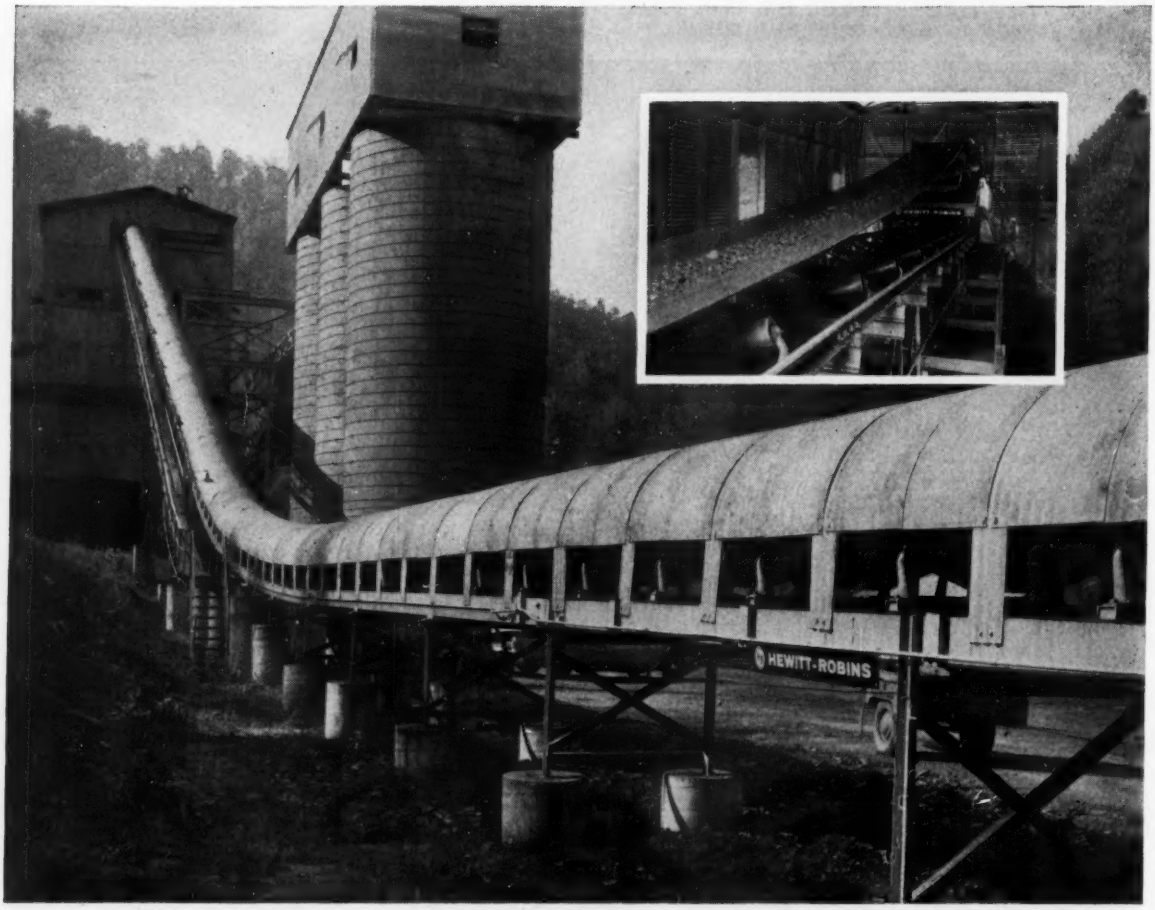
Phelps Dodge Mining Cable

- Made of highest quality copper from Phelps Dodge's own open-pit mines.
- Combines years of Phelps Dodge mining "know-how" with many years of cable manufacturing experience to give you the finest quality cable you can specify.
- Assures utmost protection against damage from mechanical and electrical hazards in both above and below ground mining operations.
- Listed by the U. S. Bureau of Mines, and approved by the Department of Mines, Commonwealth of Pennsylvania, P-114-BM.

First for Lasting Quality—from Mine to Market!

PHELPS DODGE COPPER PRODUCTS
CORPORATION
300 Park Avenue, New York 22, N. Y.

PD



Tonnage! H-R Sectional Conveyor and C/R Belt Deliver 350 TPH!

At Whitewood, Va., Jewell Smokeless Coal Co. uses an economical Hewitt-Robins sectional conveyor and a standard Ajax C/R belt to carry 350 tons of coal and rock an hour from mine to preparation plant. Built around high-tenacity rayon, this sturdy belt provides:

- Greater strength
- More elasticity
- Increased heat and humidity resistance
- More economy
- Longer service life

The quality and dependability you'll find in Hewitt-Robins conveyors and belting are built into all H-R industrial hose and materials handling equipment. For full details consult your H-R representative, or write Hewitt-Robins, Stamford, Connecticut. Ask for Bulletin 7-49.

HR HEWITT-ROBINS

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS...

CONVEYOR BELTING AND IDLERS • INDUSTRIAL HOSE • VIBRATING FEEDERS, SCREENS & SHAKEOUTS • POWER TRANSMISSION EQUIPMENT

for action, economy and compact operation



the CMI model 26 CONTINUOUS CENTRIFUGAL DRYER

This compact CMI Dryer was designed and built to fit jobs of moderate proportion (up to 20 tph) . . . whether to dry coal or minerals to less than 5% surface moisture . . . to keep coal or minerals from freezing . . . or to recover coal or minerals from slurry ponds.

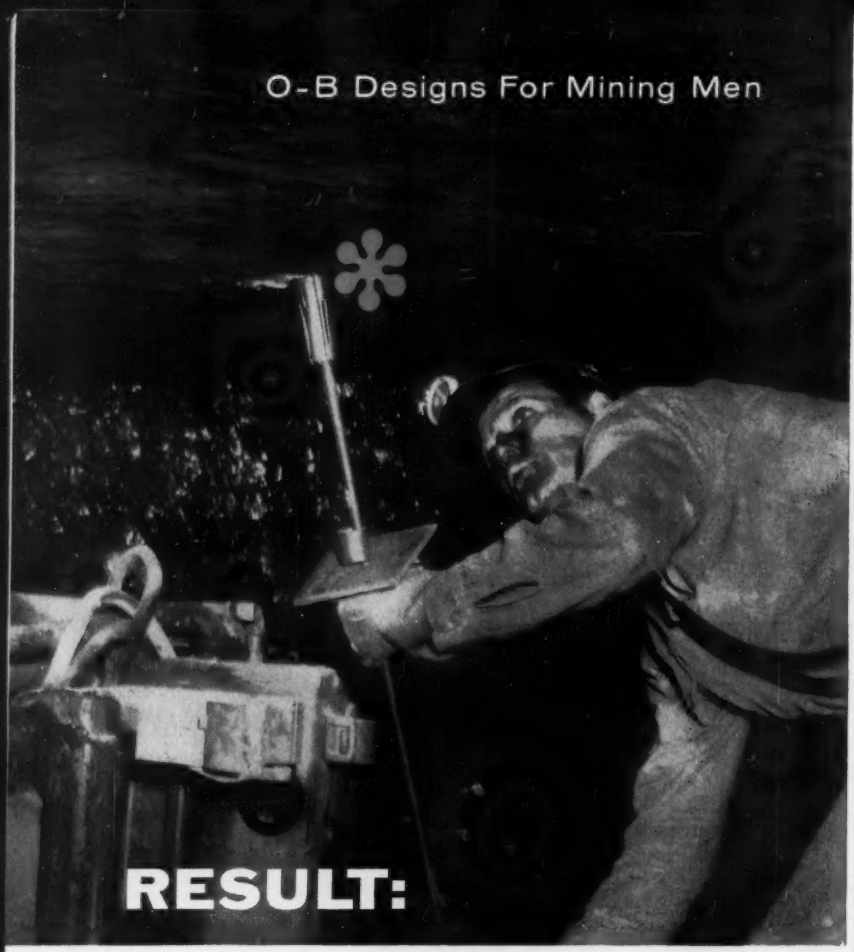
Model 26 is the ideal centrifuge where space or head room is limited, where production is less than 20 tph and where trouble and down-time free, economical and continuous operation are desired.

The CMI Model 26 is the smallest and most compact centrifugal dryer in the CMI line of dryers in operation in hundreds of installations in leading industries throughout the world.

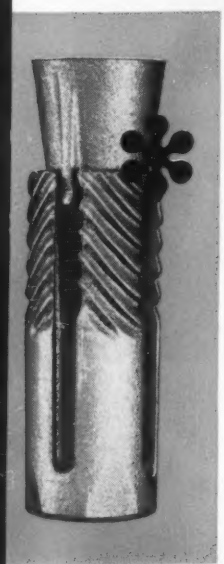
FOR COMPLETE DETAILS ABOUT THE CMI MODEL 26, WRITE OR WIRE.

CENTRIFUGAL AND MECHANICAL INDUSTRIES INCORPORATED — CMI

146 President Street • St. Louis 18, Missouri



A 4-way expansion unit that holds in soft shale or hard rock



4-WAY EXPANSION UNIT BUILDS HOLDING POWER FAST . . . because the flexible fingers of the shell are slightly pre-expanded to grip the wall even before wrenching begins.

GOES UP FAST AND STAYS PUT. When the bolt is shoved up the hole, the expansion unit holds the bolt in place until it's tightened . . . no need to have hands exposed to injury during wrenching.

GREATER STRENGTH IN HARD TOP . . . BETTER "PURCHASE" IN YIELDING TOP . . . because the expansion pressures are spread evenly over the four shell fingers to make the best use of the entire unit's strength. These are the reasons for the O-B Expansion Unit's popularity with mining men. It is easy to understand why more mine roof is supported with O-B Shells and Plugs than with any other kind.

For further information and prices, see your local O-B sales-engineer or write us now. OHIO BRASS COMPANY, MANSFIELD, OHIO. Canadian Ohio Brass Company, Ltd., Niagara Falls, Ontario.

Ohio Brass

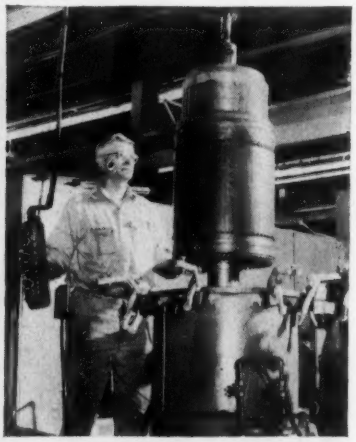
HOLAN

EXPANSION SHELLS AND PLUGS • LINE MATERIALS • SAFETY AND CONTROL EQUIPMENT • ELECTRIC HAULAGE MATERIALS

10049-M

Equipment News *(Continued)*

line, says the firm. Result, says the firm, is that gear bearings act as dowels, eliminating outmoded dowel pins.



REWINDING MOTORS — General Electric Co., Schenectady 5, N. Y. announces improved methods of rewinding and rebuilding traction motors. Contour molding motor parts with epoxy resin by two new methods, "bag molding" for commutating coils and a vacuum-pressure system for the armature, result in longer motor life, says GE. Facilities for these processes are being installed in the 15 GE service shops throughout the country that specialize in locomotive repair. The pressure-molding process inhibits the formation of voids in the system and controls the thickness and contour of the insulation. The finished coil has good dimensional tolerances which assure good heat transfer and freedom from chaffing due to vibration, says GE. The armature treatment involves several cycles of alternating vacuum and pressure to fill all voids and crevices in the winding structure.



SCREENING WATER—According to The Jeffrey Mfg. Co., Columbus 16, Ohio, the traveling water screen is the best device yet designed for removing leaves, twigs, grass and other types of

(Continued on p 159)

Quaker Thermoid

"COLEDGE" BELTING REDUCES EDGE WEAR, ADDS MILES OF USE!





Improper training can ruin a conveyor belt faster than any other abuse. Riding up and rubbing against a frame member soon wears away the stiff edge of conventional belting and exposes the carcass plys to moisture, mildew, dirt and eventual ply separation. "Coledge" belt construction was developed by Thermoid Division—to overcome this weakness and extend belt life.

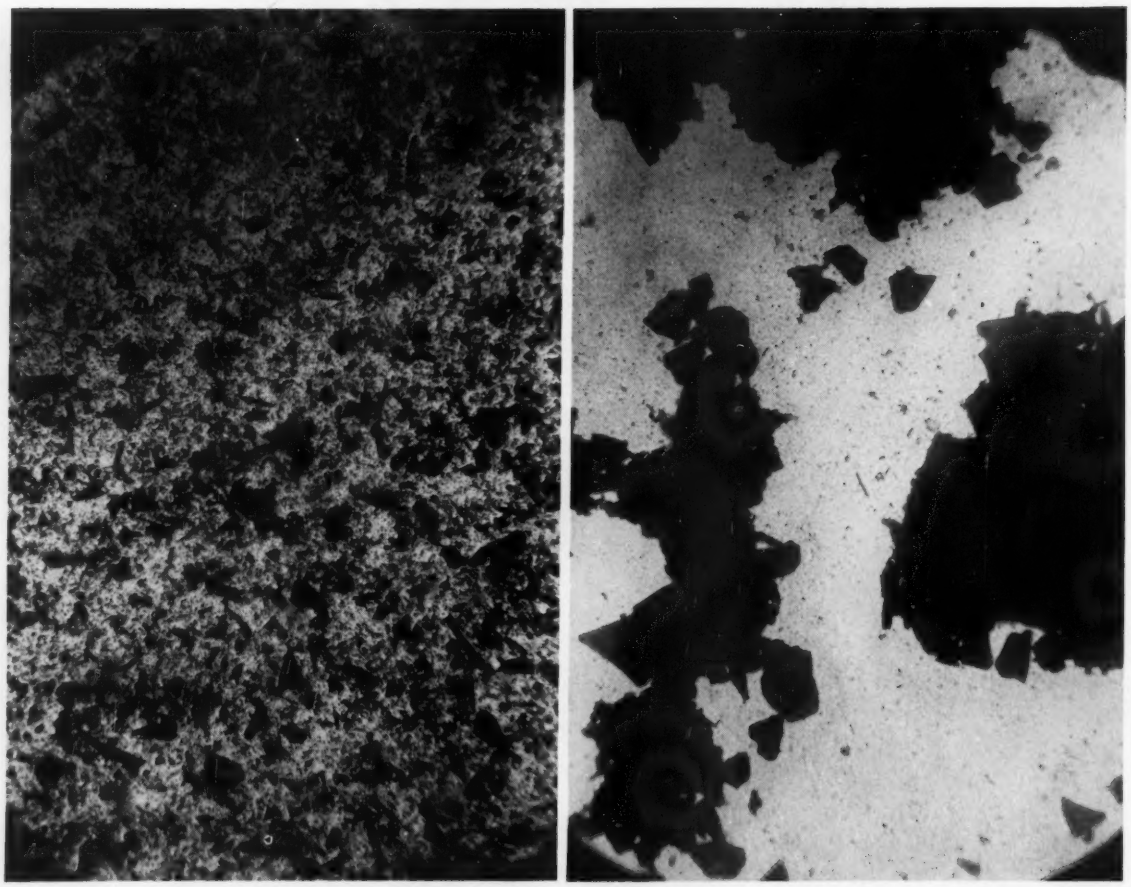
"Coledge" construction puts plenty of extra rubber on the edges where it counts most . . . the plys are stepped back to make a more flexible edge that rides with the punches when misalignment occurs. This "Coledge" construction can put many extra miles on your system, especially in coal fields and sand and gravel pits where most belt failures are the result of excessive edge wear. Exclusive with Thermoid Division, "Coledge" construction is available in any standard type belt your application may require.

So, if you have an edge-wear problem with conveyor belts, specify "Coledge" construction. See your Thermoid Division industrial distributor for technical data or assistance, or write *Thermoid Division, H. K. Porter Company, Inc., 200 Whitehead Road, Trenton 6, New Jersey.*

THERMOID DIVISION PORTER **H. K. PORTER COMPANY, INC.**

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

SEPARAN AP30



Unflocculated wash water fines.

Wash water fines flocculated with Separan AP30.

Here's Why Separan AP30 Can Help Save You Money in Your Coal Washing Plant

These photomicrographs show that Separan® AP30 is an effective flocculant. They *do not* show, however, other important reasons why many operators are changing to Separan AP30.

They do not show how little Separan AP30 it takes —0.01 to 0.1 pounds per ton of solids!

They do not show how fast the flocculated fines settle out—30 to 60 feet per hour with as little as 0.02 to 0.04 pounds of Separan AP30 per ton of solids.

They do not show how Separan AP30 helps to keep the investment in equipment, such as thickeners, at a minimum. Thickener efficiency is greatly increased when Separan AP30 is used.

Most of all, they don't show how Separan AP30 has helped many operators keep coal washing costs at a minimum. In one 18,000-ton-per-day plant, feed water containing about 15 per cent solids goes through three thickeners. Clear-water overflow is maintained in all three thickeners with 0.025 pounds of Separan AP30 per ton of fines. *Cost: $0.03 per ton.* In a 23,000-ton-per-day plant, 12,000 gallons of water per minute, containing one per cent solids, overflows the primary thickener. Five to seven feet of clear water is maintained in the secondary thickener with 0.013 pounds of Separan AP30 per ton of solids. *Cost: $0.015 per ton.*

Find out how Separan AP30 can reduce the cost of your coal washing operations. Dowell will arrange—without obligation to you—a demonstration at your plant. Just contact the Dowell District Office at 1918 Highway 41 North, Evansville 7, Indiana. The telephone number is HArrison 5-1353.

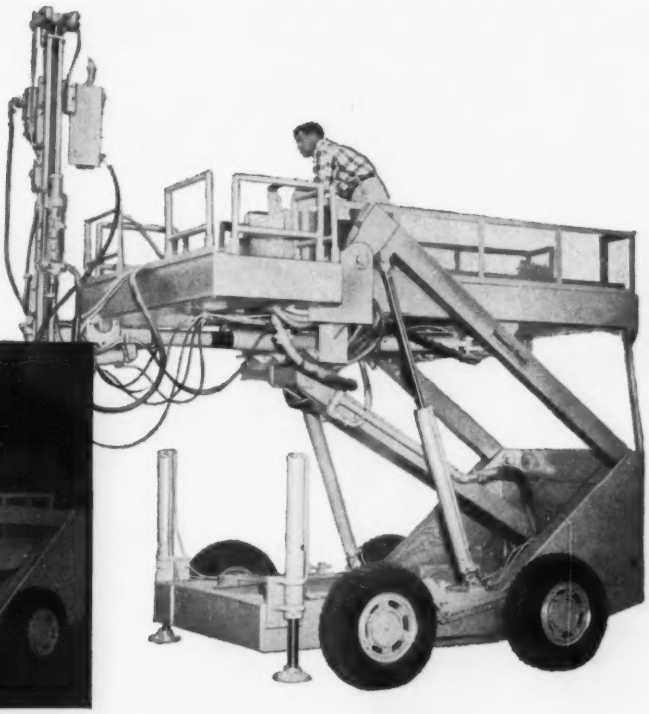
Services to the coal industry DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

MECHANIZED ROOF-BOLTING

RIGHT—I-R Roof-Bolting Jumbo with elevator raised to upper position for working in a 14-foot seam.

BELOW—same jumbo, with elevator lowered, is right height for an 8-foot seam.





Special I-R ROOF BOLTING JUMBO drills, drives, and tightens bolts in 8 to 14-ft seams

Ingersoll-Rand rock drill engineers have come up with a unique solution to a troublesome roof-bolting problem on a job where with conventional stopers and temporary stagings, roof-bolting crews were hard pressed to keep ahead of drilling operations in a room-and-pillar mining system. Drillers often had to wait for roof bolts to be set before they could move in on a new face. Now a two-man crew easily keeps ahead of all drilling operations.

Each self-propelled jumbo consists of an elevator platform which carries a Hydra-Boom-mounted vertical drill feed with DB-30 drifter and Torque Control Impactool.

In operation, the jumbo is propelled into approximate drilling position by I-R air-motor drives—anchored with hydraulic leveling jacks—and the platform raised by hydraulic cylinders to the desired height. The drill is spotted in position by the Hydra-Boom and the hole is drilled. The drifter is then run down the feed, the steel removed and the Impactool swung into position above the drill. The roof bolt is inserted and drill feed raises the wrench into position for tightening the bolt to the required torque. All operations are throttle controlled from the upper deck.

If you have a drilling problem, Ingersoll-Rand's specialized experience can help you solve it—quickly and efficiently.

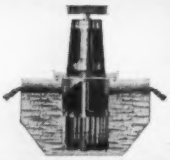
Ingersoll-Rand

5-904 11 Broadway, New York 4, N.Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR ROCK DRILLING

WEMCO EQUIPMENT
FOR COAL PREPARATION

FROTH FLOTATION



WEMCOAL FLOTATION MACHINE

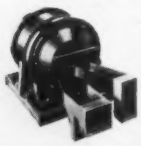
WEMCOAL Flotation cells and allied equipment are the solution to washery water reclamation and stream pollution problems, and have been chosen for over 90% of recent froth flotation installations. Low ash product with high recovery and low reagent cost are principal reasons for their wide acceptance in the industry.

HEAVY MEDIA SEPARATION



WEMCO MOBIL-MILL

A complete, pre-engineered, pre-fabricated HMS plant for profitable, premium coal production from first day of operation. Integrated design for rapid erection — and one man operation — even by inexperienced personnel. Answers ash reduction problems economically, profitably.



WEMCO DRUM SEPARATOR

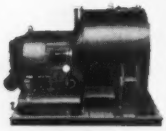
Incorporated in Wemco Mobil-Mill for coal cleaning. Float material overflows; sink material is raised by lifters. Two compartment drums produce a true sink, true float and middling. Double drums make two separations.



WEMCO CONE SEPARATOR

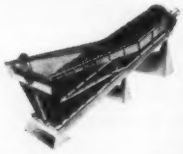
For sharp separations where longer retention time is required in size range of 4 inch to approximately 10 mesh. Clean coal floats to the surface and overflows; sink material removed by airlift.

DEWATERING AND PUMPING



WEMCO SIEBTECHNIK CENTRIFUGAL DRYER

A horizontally mounted vibratory screening centrifuge, proven superior for the drying of washed coal fines. Efficient dewatering is accomplished as solids are passed through a truncated screen whirled at high speed. Axial vibration keeps mass of particles loose, aiding dewatering and movement to discharge. Speed of basket, as well as amplitude and frequency of vibratory motion can be easily adjusted to meet requirements.



WEMCO COAL SPIRAL

High capacity, low cost dewatering device for coal from ⅜ inch to 48 mesh. Also serves as classifier for slimes and fines, making sharp overflow separation at 35, 100 or other desired mesh size. An important use is for dewatering of wet screen underflows.



WEMCO TORQUE-FLOW PUMP

Proven Torque-Flow pumping principle incorporates recessed impeller, continuous open passage. Permits pumping of large solids in slurry without clogging or degradation, and with minimum wear. Torque-Flow Pumps are ideal for pumping feed to cyclones.

WEMCO®

a division of

Western Machinery Company

650 Fifth Street, San Francisco 7, California

other offices in:

New York Toronto

Hibbing Paris

"RATIO-FEEDER* saves us 20 seconds in the unloading of each shuttle car...

we have found your Ratio-Feeder to be a very valuable piece of machinery in our Thunderbird Mine," says WILBUR A. ENDICOTT, General Superintendent, Ayrshire Collieries Corp.



1. Shuttle car unloads at its maximum discharge rate into a Ratio-Feeder in Ayrshire's Thunderbird Mine. The 20 seconds saved increases mine output... extends shuttle car haul distance... lowers cost per ton.



2. "The wide intake conveyor of the Ratio-Feeder takes the full load of the shuttle car with a minimum of spillage and holds down clean up costs," General Superintendent Endicott reports.



3. Ratio-Feeder discharges at a uniform rate reducing belt overloading, damage and wear. "It can be set to proportion the coal so that several panels can unload onto the same belt without stopping any one of the others," says Mr. Endicott.



4. Ready for the next shuttle car. This Ratio-Feeder was installed in September 1959, had handled 250,000 tons of coal when picture was taken 6 months later. Two more Ratio-Feeders have since been installed in the Thunderbird Mine.

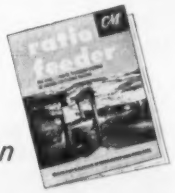
The Ratio-Feeder is now demonstrating in mine after mine that it is the answer to the age-old problem of getting coal from a shuttle car to a belt...*fast*...without damage to the belt... increasing belt haulage capacity...and with a minimum of spillage. The advantages that Ayrshire Collieries and other well-known mines are getting from the Ratio-Feeder can be yours too. It will cost you nothing at all to get the complete *proved* facts as to where this time-saving machine is working and what it is accomplishing...and what it can do for you. Simply write or call us.



Ratio-Feeders are now available in six standard models with capacities from 2¼ to 15 tons.

COLOR MOVIE. See the Ratio-Feeder at work in a mine. Ask to have us show you this film at your office.

send for bulletin



CM. MINE EQUIPMENT

COLUMBUS McKINNON CHAIN CORPORATION

Mining Equipment Division

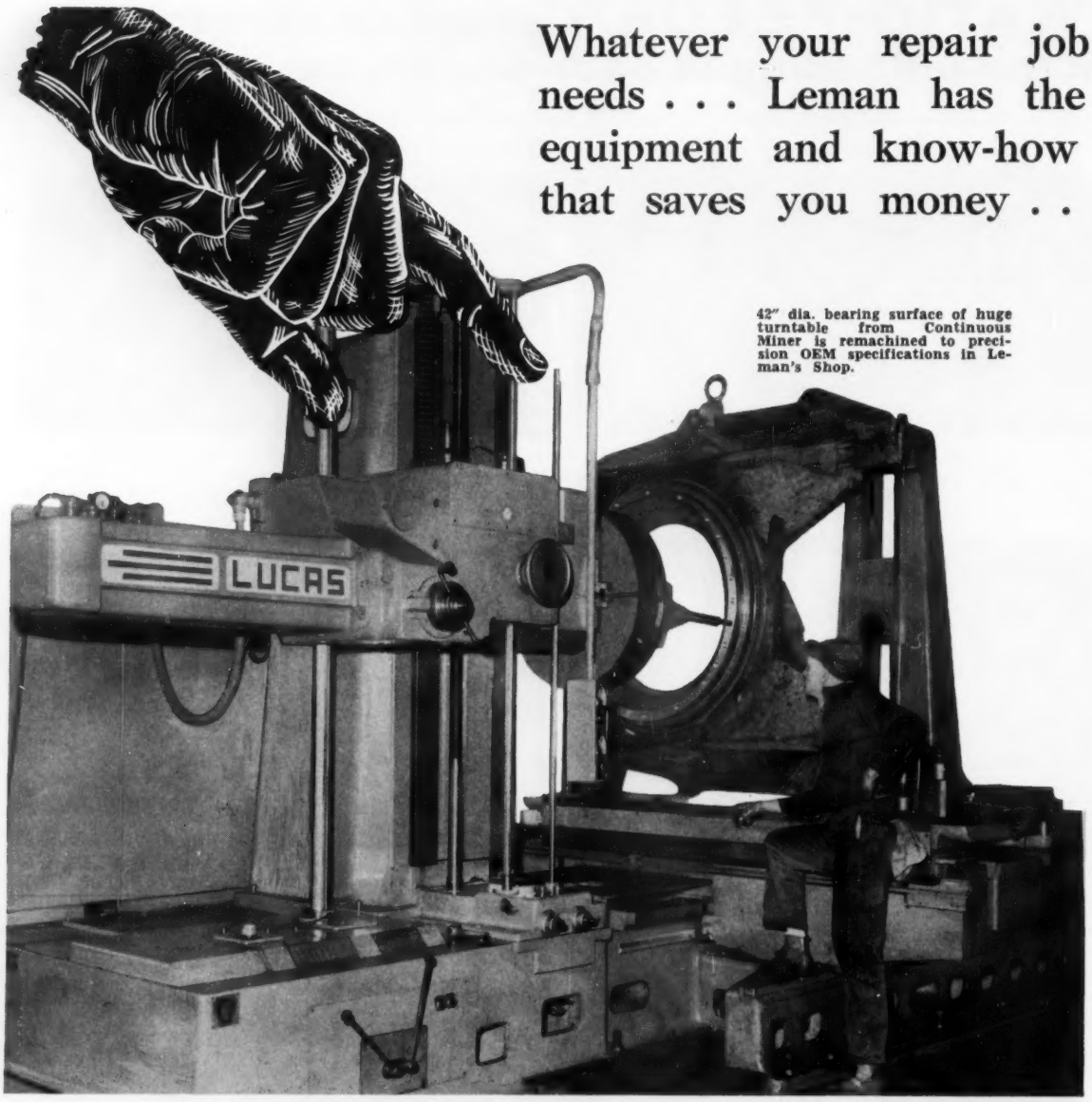
53 FREMONT AVENUE, TONAWANDA, NEW YORK

Manufacturers of **CM HOISTS, CHAIN AND CONVEYORS**

*Trademark Pat. Pend.

MATERIALS HANDLING EQUIPMENT SPECIALISTS FOR 75 YEARS

Whatever your repair job needs . . . Leman has the equipment and know-how that saves you money . .



42" dia. bearing surface of huge turntable from Continuous Miner is remachined to precision OEM specifications in Leman's Shop.

Get Leman to handle your repair work . . . save time and money with guaranteed results. Leman restores worn or damaged equipment to original condition . . . gives you new equipment performance at a fraction of ordinary replacement costs. Leman's fully equipped, modern plant assures you of fast, economical repairs on any make or model of mobile loading and mining machinery or electric locomotives.

Heaviest equipment made "as good or better than new" . . . old equipment converted to latest models . . . new parts designed for special needs . . . only genuine OEM replacement parts used. Just a few of the reasons why Leman has led in heavy mining machinery repairs for nearly 40 years . . . good reasons too, why it will pay you to consult Leman when you want to save money on your own repair work.





Heavy, continuous mining equipment leaves Leman's Repair Shop in "Good-as-New" condition. Gets back on the job in record time.

Ask About Fast Pick-up and Delivery Right To The Job Site.

Phone or Write for Prompt, Courteous Service.

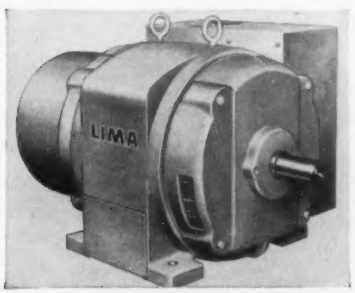
LEMAN MACHINE COMPANY

BOX 236, PORTAGE, PENNA. **PHONE PERSHING 6-3731**

Equipment News (*Continued*)

debris from surface waters being reclaimed and prepared for further use. It can be designed for handling large volumes of water with wide variations in depth and with comparatively low loss of head through the screen when the screening medium is clean. The Jeffrey screen, usually installed vertically in the intake structure, consists of moving panels or baskets covered with suitable wire mesh attached to two strands of 24-in pitch Steel-Thimble roller chain. It may run continuously or intermittently depending on plant requirements and may be furnished with manual, time or differential level control.

SYNTHETIC OIL—A synthetic oil for extreme low-temperature operations is being marketed by the Lehigh Chemical Co., Chestertown, Md. Called Anderol L-423, this light-viscosity diester oil features a pour point of below 105F and a viscosity at 90F of only 5,000 C's. These properties combine with good oxidation stability and low evaporation to produce a superior lubricant that meets the requirements of low starting and running torques over a temperature range of −100F to 250F, according to the firm.



GENERATORS—A new line of "Precise Power" and "Special Brushless" AC generators and motor generators is being marketed by The Lima Electric Motor Co., Inc., Lima, Ohio. Units come in ratings from 5 kw through 100 kw in open-type construction with static exciter-regulators. With dripproof construction, the AC generators are adaptable for engine mount or direct coupling to driving motor. Synchronous generators, rated from 5 kw at 1,800 rpm to 100 kw at 1,800 rpm, are equipped with induction-exciter-regulars, inherent regulation with no external controls.

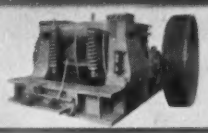
Equipment Shorts

Valves—Crane Co., Chicago 5, has introduced a new line of 150- and 300-lb steel flexible-wedge disc gate valves with a new flexible-wedge disc. This disc marks the most significant gate valve improvement in 25 yr, according to Crane. Known as "Flex Gate," the line provides

McLANAHAN SINCE 1835

CRUSHERS for COAL and REFUSE

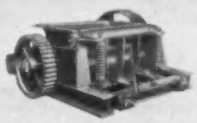
SINGLE ROLL



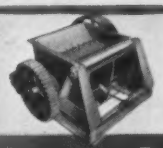
Rockmaster — High in capacity and ruggedly constructed, it crushes hardest rock, slate and similar mine refuse.



Super Black Diamond — An all-steel, intermediate-duty crusher, this provides many Rockmaster features at moderate cost.

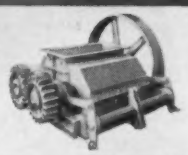


Black Diamond — Steelstrut Toggle protection against uncrushable materials and quick size adjustment are features of this fabricated steel crusher.

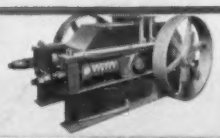


Bantam Buster — This is a portable, low-cost unit with a high ratio of reduction. Trouble-free maintenance is a feature.

DOUBLE ROLL

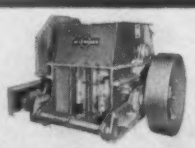


Black Diamond Double Roll — This was designed for moderate to fine reduction of coal where a low ratio of reduction is satisfactory.



Heavy-Duty Double Roll — Economical and noted for service, it is ideal for fine reduction of mine refuse.

TRIPLE ROLL



Black Diamond Triple Roll — Radically new 2-stage design reduces run-of-mine and direct open pit feed coal to fine sizes.

Bulletins Available on All Crushers

McLanahan and Stone Corporation

250 Wall Street, . . . HOLLIDAYSBURG, PA.

Mine, Pit and Quarry Headquarters Since 1835

FOR THE RIGHT COMBINATION ON YOUR NEXT SHOT...

WHICH

when you use the right combination of explosives, blasting agents, and blasting techniques, all your equipment moves in sooner... works faster... produces more.

STRIPPING



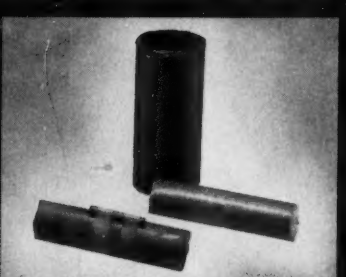
PELLETS, a new form of ammonium nitrate developed by Atlas, are porous, compact particles that have both the density and sensitivity required for efficient AN-oil blasting.



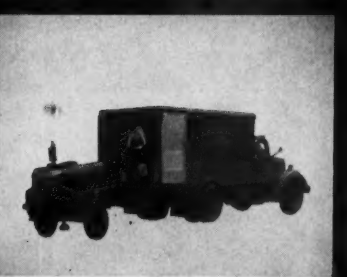
KOLMITE is an economical dynamite specially developed by Atlas for shooting coal in strip operations where the coal must be blasted for easy, efficient digging.



GIANITE, a pre-mixed ammonium nitrate blasting agent, eliminates the need for troublesome on-site mixing. Well balanced mixing assures you of complete, efficient detonation.



GIANT "75" PRIMERS and SUPER "G" BOOSTERS have the wallop required to assure complete, efficient detonation of both field mixed and plant mixed blasting agents.



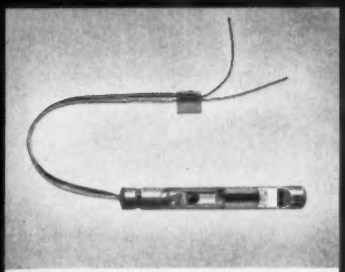
JETLODER, introduced in 1958, is the first high capacity pneumatic blow-loading machine. Has non-sparking cast aluminum body. Mixes and loads 80 lbs. of AN in few seconds.



AMOCORE is a mixture of ammonium nitrate and carbonaceous material, packed with a waterproof gelatin core. It is available in a wide range of diameters and velocities.

EXPLOSIVE?

UNDERGROUND



KOLMASTER® millisecond delay electric blasting caps achieve the staggered action so important in producing uniform breakage and control in multiple hole shooting.



COALITE® and GELCOALITE permissibles are now available from Atlas in a revised range of strengths and velocities to give best performance in all underground conditions.



FEMCO 20-shot permissible blasting machine has been specially designed for use in multiple hole shooting underground. Also, it is approved by the U. S. Bureau of Mines.

Whether you are stripping coal or mining it underground, one fast road to lower operating costs is thru better use of explosives and blasting techniques. Mine operators are finding that their lowest true blasting costs depend on determining which explosives, and which blasting methods, combine to give the most uniform fragmentation, the best displacement, and the lowest overall cost.

Atlas alone offers a complete line of explosives, blasting agents (including *all* forms of ammonium nitrate), and blasting supplies. They are designed to provide every possible combination to meet each type of blasting problem, over a wide range of conditions. In addition to being backed by this complete line of products, your Atlas Representative can help you with newly developed blasting methods and the very latest techniques.

In coal stripping, for example, one new method that has been tried and found extremely successful is called explosives stripping, and employs Rockmaster millisecond delay electric blasting caps to gain greater throw of material. Using this new technique, one strip mine near Pittsburgh has been moving more than 45% of the overburden to the spoil pile. With bottom detonation, the rock sweeps across the pit and onto the spoil pile, requiring no mechanical handling. Beside uncovering 30 to 40% more coal in a given length of time, they also credit this new method with extending the operating life of their equipment, cutting maintenance costs, and reducing bulldozer reclamation time.

In underground coal mining, the use of Kolmaster millisecond delay electric blasting caps for multiple hole shooting is rapidly increasing. Greater safety is provided by this method, particularly in lessening the hazards of roof falls and easing the work of the shot firer. Although standard blasting procedures must be changed, and care must be exercised to be certain all state regulations are met, this new method warrants careful consideration. In addition, permissibles are being made safer with formulas containing greater percentages of salt to guard against explosions due to improper loading.

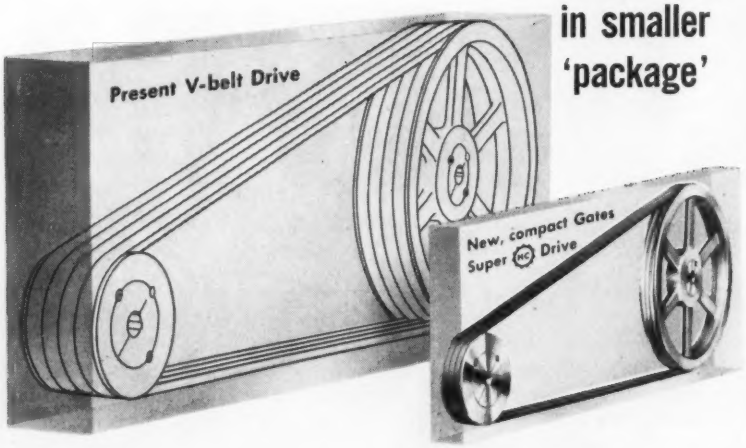
These examples are typical of the advancements being made in blasting technology. Ask your Atlas Representative about these new developments, and about the many products in the complete Atlas line. Working with him, you can determine the combination of explosives, blasting agents, and particular blasting methods that will be most profitable for you on every shot.

There is only one way to look at explosives costs, and that is: which explosive will give you the most payload service from all your equipment? Our blasting cost chart, slide rules, and technical literature are designed to help you do just that. Be sure to ask your Atlas Representative about them . . . or, write directly to:

ATLAS POWDER COMPANY
Explosives Division, Wilmington 99, Del.

ATLAS EXPLOSIVES

Same HP capacity in smaller 'package'



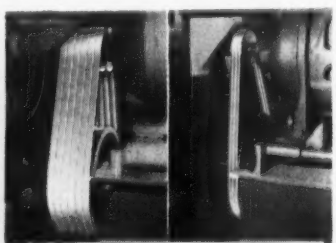
Industry cuts drive costs as much as 20% with Gates high capacity V-Belts

By putting power transmission in a smaller package, Gates 'performance-proved' Super HC V-Belt Drive has cut costs all along the line—for all kinds of industries—since its introduction more than a year ago.

As a replacement drive on equipment *inside* the plant, or as the drive on equipment *manufactured for sale* the Super HC Drive has enabled thousands of industrial users and OEM's to reduce sheave diameters 30% to 50%, overall drive space up to 50%, and drive weight 20% and more. *Initial drive cost has been cut as much as 20%.*

Nation-Wide Engineering Service

A Gates Distributor can show you how to effect savings with Super HC V-Belt Drives. Ask him for your free copy of "*The Modern Way to Design Multiple V-Belt Drives*," or write to The Gates Rubber Company Sales Division, Inc., Denver, Colorado.



BEFORE ◆ AFTER ◆

COMPARE: Conventional drive at left was replaced with Gates new Super HC V-Belt Drive at right. Three of Gates new, narrow HC V-Belts do the work of the former 6 standard width belts. In this application the new drive actually takes *one-third* the space of old!

TPA 535

The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates — World's Largest Maker of V-Belts

Gates Super HC V-Belt Drives

Equipment News (*Continued*)

working-pressure ability from 40 psi at 1,000F to 275 psi at 100F for the 150-lb valve. The 30-lb valve has a range from 85 to 720 psi at a similar temperature range.

Welding—Stainless-steel welding wires for use with the submerged-arc welding process are being marketed by Air Reduction Sales Co., New York 17. Chemical composition of the stainless wires rigidly conforms to the AWS and ASTM standards for corrosion resisting and chromium-nickel steels, says the firm. Automatic welding wires are available for use with 308, 309, 310, 347 and 502 stainless in 25- and 50-lb coils.

Lubricator—A new floor-type heavy-duty conveyor lubricator automatically injects oil or grease in wheel bearings in trucks, dollies and pallets used with floor conveyors, reports Olsen Mfg. Co., Royal Oak, Mich. Model 152 was designed for use in steel mills, but is now available as a standard model for use in quarries, foundries, coal handling, mining and other heavy-duty applications.

New Electrode—A new type of metal-removal electrode, grade Q, has been developed by Arcair Co., Lancaster, Ohio. The company is selling the electrode to customers using ½-, ⅝- and ¾-in electrodes in their work. The new composition eliminates thermal shock which can cause spalling and splintering off of electrodes made from conventional materials.

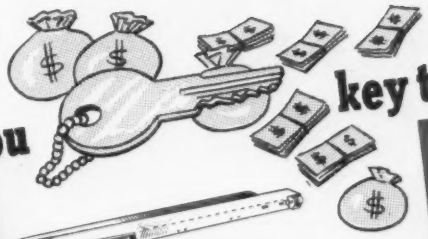
Ring Seal—Just introduced by the Gits Sealing Device Div. of Gits Bros., Chicago 23, is a non-split hydraulic and pneumatic linear-motion ring seal. Its special all-metal construction permits use at temperatures from -425 to 1,500F. The product was developed to meet the demands for high-temperature seals in hydraulic actuators, for high-temperature static seal applications and for high-temperature swivel joint seals.

New Pump—For an installation requiring a large volume of water from 6 in. or larger, deep wells, the new Series UF Turbine Bowl submersible pumps announced by Goulds Pumps, Inc., Seneca Falls, N. Y., is available. Built in 16 sizes from 5 to 40 hp, the units, will provide capacities up to 180 gpm from well depths to 1,450 ft.

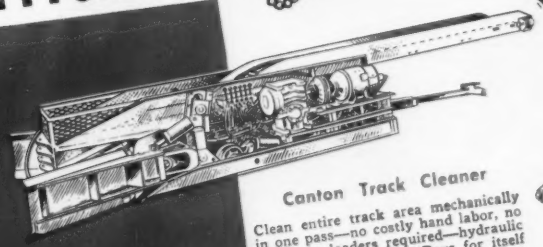
Cutters—Two new cutters for producing clean, square ends on steel tubing as well as on copper, brass and aluminum tubing, are available from Parker-Hannifin Corp., Cleveland 12. The "Kloskut" 216S, for tubing sizes ranging from ⅛

(*Continued on p 167*)

"Canton" ...Gives you key to the money vault!

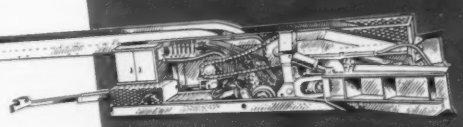


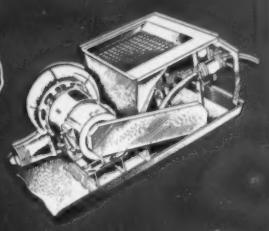
Help yourself to unlimited profits with equipment that opens up new areas of increased savings ...performs prodigiously over long, long periods of time, pays for itself in unbelievably short time.



Canton Track Cleaner

Clean entire track area mechanically in one pass—no costly hand labor, no dozers or loaders required—hydraulic controls throughout. "Pays for itself in one sweep through mine." Now used in coal, iron, copper, lead, potash, and salt mines.





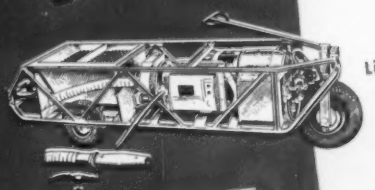
Mighty Midget Duster

Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines—inexpensive—capacity 7 tons dust per shift.



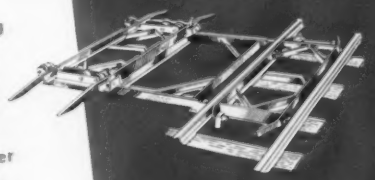
Dustmaster

The track mounted Hi-pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 feet from haulway.



Little Chief for Wet Or Dry Dusting

Rubber tire model 22½" high—skid model 18½" for shuttle buggies, belts or mine cars; hydraulic self-propelled model available. 34 to 60 lbs. dust per minute through 50 to 250 ft. of 2" hose.



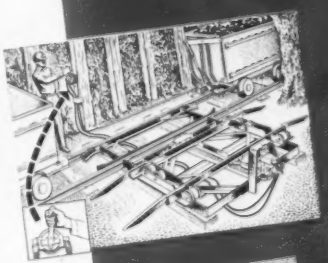
Manually Operated Car Transfer

No alterations to track—quickly installed and relocated — less rib to shoot than for jump switch — no hazards of cherry picker, anti-friction bearings for easy hand operation.



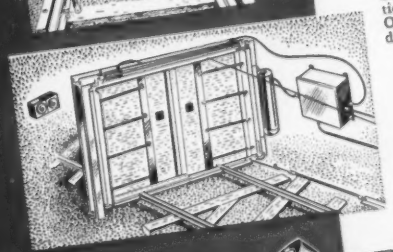
Air Power Car Transfer

One man does the work of three and faster. Entire train loaded out on a single track. Expedites servicing cars to mucking machine.



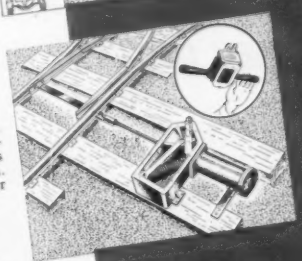
Canton Automatic Mine Doors

The Automatic Door operates mechanically by weight of car on activating levers. Air power operation may be had where desirable. Operates at any trip speed. Two doors provide air lock.



Track Switch Thrower

Either electric or air operated. Route selections made by motorman at full trip speeds. Eliminates accident potential and extra man. Also ideal as Derailer. Manual or automatic contactors available.



Canton Cable Splicers

Reduce down-time in splicing cable. Machine man should carry a pocketful. Just pound around cable and keep on working. No special tools required.



Half Century of Dependable Service

Remember you can install a "Canton" now and pay us out of savings.
Write for complete brochures. Please use street and zone numbers.

the American Mine Door Company

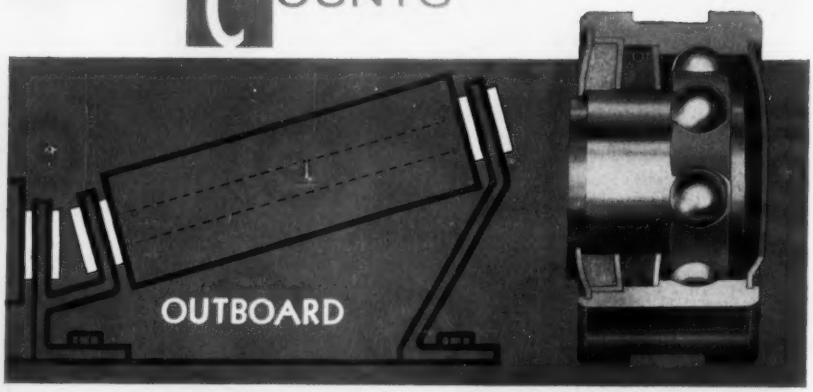
2057 DUEBER AVENUE, S.W. CANTON 6, OHIO

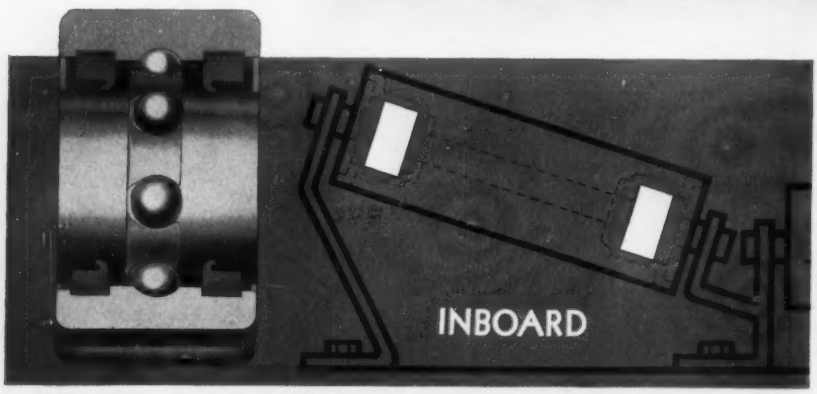
IN *Conveyor Roll* BALL BEARINGS

MARLIN-ROCKWELL RELIABILITY COUNTS

MRC CONV-3-SF

Made for simplified mounting bracket with milled slots in outer ring. Metal shield is backed by impregnated felt and a spring controlled cork seal, assuring long life without relubrication while providing a very effective seal. All exposed surfaces are plated for resistance to corrosion.



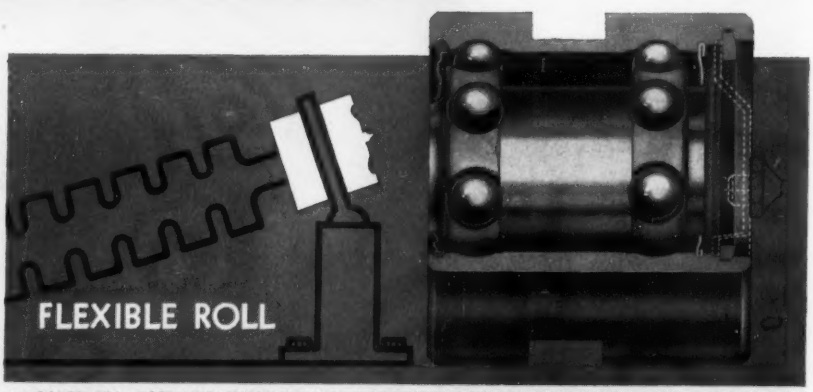


MRC CONV-3-J

Designed for mounting directly into roller. Equipped with positive contact oil resistant synthetic rubber seals, which retain lubricant for life of bearing and protect against entrance of dust and other foreign matter. The sealed-for-life feature of these bearings cuts both maintenance and construction costs.

MRC CONV-4E-2

A double-row inverted contact angle bearing for more internal rigidity which insures alignment of seals and sealing surfaces. It is prelubricated and equipped with MRC Synthe-Seal® on inboard face. Provision is made for end cap, furnished by customer on outboard face, when relubrication is demanded by severity of environment.



BACKED BY 62 YEARS EXPERIENCE IN THE MANUFACTURE OF BALL BEARINGS

Consult Our Sales Department for Further Information

MRC BALL AND ROLLER *bearings*

MARLIN-ROCKWELL CORPORATION

JAMESTOWN, NEW YORK



BOSS of the Mountain!

The haul is all down hill for a fleet of KW-DART 60SBDT coal haulers operating in West Virginia. They safely ease 60 tons of coal down the mountain from mine to tipple—and on grades up to 14%. From bumper to tail light, KW-DART designed these haulers for maximum performance under all conditions. 450 H. P. and proper gear ratios assure speedy returns up the mountain to the mine. Engineered for the job—KW-DART is surely "Boss of the mountain."

Builders of heavy duty trucks since 1903

KW-DART TRUCK CO.®

1301 North Manchester Trafficway • Kansas City 41, Missouri, U.S.A.



Dependable Haul Road Maintenance

IN TODAY'S MODERN MINES AND QUARRIES, good haul roads are important for top operating efficiency. Haulage units can deliver the load faster, have better fuel economy, less repairs and have greater operator and vehicle safety.

A Huber-Warco motor grader assures dependable haul road maintenance. These rugged graders are designed to maintain roads quickly and efficiently, even in extreme weather conditions.

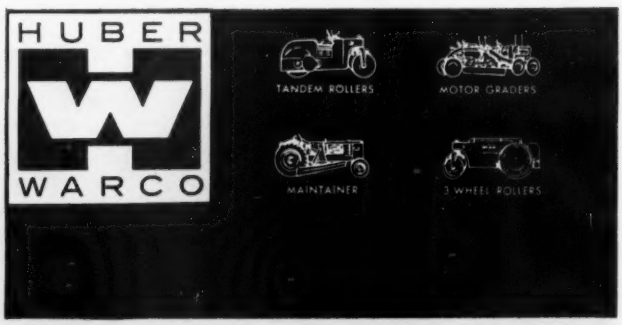
Heavy construction means years of dependable service with less downtime for repairs. Fast acting, full hydraulic controls give an operator complete blade control from the cab for grading, ditching, bank sloping and other grader functions.

There is a Huber-Warco motor grader to fit your needs – models include 85 to 160 horsepower standard transmission graders and 102 to 195 horsepower models featuring torque converter and powershift transmission.

For dependable haul road maintenance see your nearest Huber-Warco dealer for the complete story.

HUBER-WARCO COMPANY

MARION, OHIO



Equipment News (*Continued*)

to 1 in in diameter, has a roller specially designed to permit cutting off flared ends of tubing close to the flare. The large Model 1232 cutter is for tubing sizes of ¾ to 2 in outside diameter.

Free Bulletins

Splicing—Okonite Co., Passaic, N.J. A 30-p book on splicing with rubber-Neoprene cables and two 16mm colored films entitled "Spliced for Life" available on request.

Slings—American Chain & Cable Co., Inc., Wire Rope Sling Dept., 929 Connecticut Ave., Bridgeport 2, Conn. Bulletin DH-425 covers new Double Green Stripe ACCO-registered VHS Strand-Laid wire rope slings, said to be the strongest in the world.

Belts—Dayton Industrial Products Co., Div. of Dayco Corp., 2001 Janice Ave., Melrose Park, Ill. Booklet covers line of industrial V-belts including Cog-Belt and Poly-V and fractional horsepower types, as well as sheaves and industrial hose.

Flotation—Denver Equipment Co., 1400 17th St., Denver 17. Bulletin F10-B97 concerns equipment for coal flotation, describes why coal flotation plants in the United States use Denver "Sub-A" flotation cells.

Warner—General Electric Communication Products Dept., Lynchburg Va. Bulletin ECM 119 discusses a high-capacity alarm/control system for locating faults at unattended remote operations and controlling "on-off" functions remotely.

Full Line—Syntron Co., Lexington Ave., Homer City, Pa.—Catalog 605 presents descriptions, data and specifications on all company products, including vibratory materials-handling equipment, power rectification equipment and power tools.

Drives—The Louis Allis Co., 427 E. Stewart St., Milwaukee 1. Bulletin 101 describes operation and performance of company's Select-A-Spede drives.

Cleaning—Ducon Co., Inc., 147 E. 2nd St., Mineola, N.Y. New high-energy dust and fume scrubber, the Oriclone, is described in a 4-p bulletin, No. W-8560.

Lubricant—The Whitmore Mfg. Co., Cleveland 4. New folder explains why a special lubricant makes open chains last up to 3 times longer.

(Continued on p 168)



GUNDLACH

Takes the Crushing Problem DOWN TO SIZE!

YOU BENEFIT...

By Control of Top Size — Crushing to size in one operation eliminates recirculating load . . . saves time and equipment . . . increases overall plant capacity.

By Less Fines — More saleable coal in stoker sizes means more dollars per ton . . . if crushing prior to washing, fewer fines means lower washing costs.

By Flexibility . . . Can handle larger lumps and frozen coal . . . hand wheel adjustment allows you to fill any order down to ¾" top size . . . orders heretofore uneconomical to fill are now yours.

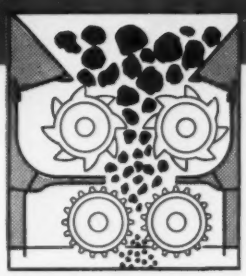
By Dependability . . . Ever-increasing list of satisfied users.

By Economical Operation . . . Less maintenance . . . Less H.P. per ton of crushed coal . . . One Crusher . . . Lower initial investment . . . No wasted labor in adjusting crusher.

YOUR CUSTOMER BENEFITS...

By Control of Top Size . . . Less unburnt coal in ashes . . . More BTU output per ton . . . Lower ash handling costs . . . Greater overall utilization.

By Less Fines . . . Simplifies unloading . . . increases boiler efficiency.



Uniformity in size consist of GUNDLACH crushed coal eliminates customer complaints, gives customer satisfaction, and increases production.

If you have a crushing problem, you'll find a GUNDLACH representative as near as your telephone.

OUR REPRESENTATIVES AT YOUR SERVICE

ANDREW M. GARDNER, 626 Park Lane, Greensburg, Pa., TEmple 4-4346 • MARSHALL EQUIPMENT CO., P. O. Box 1367, Huntington 15, W. Virginia, JA 3-8691 • CLYDE E. CLARKSON, 4831 E. Harvard Lane, Denver, Colo., SK 6-5277 • J. SCHONTHAL & ASSOC., INC., Suite 309, 224 S. Michigan Ave., Chicago 4, Ill., WA 2-8350 • A. R. AMOS COMPANY, 713 Commercial Trust Bldg., Philadelphia, Pa., RI 6-3675 • RICHARD M. WILSON, 27 Oak Park, Wheeling, W. Virginia, Woodsdale 586.

T. J. GUNDLACH MACHINE CO.

P. O. BOX 283 • BELLEVILLE, ILL.

Division of J. M. J. Industries

Equipment News (*Continued*)

Welding—Arcair Co., Box 431, Lancaster, Ohio. Instruction manual describes operation and use of the carbon-arc-welding process.

Shovel — Manitowoc Engineering Corp., 741 N. Milwaukee St., Milwaukee 2. Two-color folder on the 1 1/4-yd Model 2000 shovel, convertible to crane, dragline and trench hoe.

Engines—Caterpillar Tractor Co., Engine Div., Peoria, Ill. Handbook called "Judging Engine Quality" tells what to look for to get top performance from an engine.

Tough Metal—Cross Perforated Metals Plant, National-Standard Co., Niles, Mich. Engineering data for complete specifications of heavy-gage perforated metal is outlined in a 40-p brochure.

Tractor—Caterpillar Tractor Co., Peoria, Ill. New "Work-Styled" D6 Series B tractor is featured in a 12-p brochure. It has a diesel engine rated at 93 flywheel hp.

Bus Duct—Westinghouse Electric Corp., Box 2278, Pittsburgh 30. Application data for plug-in low-impedance high-frequency and electric-utility bus duct is contained in a new 12-p bulletin.

No Rust—The Bayless-Kerr Co., Hanna Bldg., Cleveland 15. New folder tells how "Rust-I-Cide" saves labor and avoids replacement costs by removing rust and conditioning metal surfaces.

Heaters—D. J. Murray Mfg. Co., Wausau, Wis. Revised 4-section catalog describes Grid cast-iron steam heat transfer surface unit heaters with general treatment on corrosion in unit heaters.

First Aid—Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8. Four sizes of first aid kits in all-weather cases are described in a new bulletin, No. 0401-10.

Pulleys—Western Conveyor Co., Box 357, Boise, Idaho. New Schrock motorized pulley selection catalog gives specifications and dimensions for latest model pulleys from 1 to 75 hp.

Scales—Cardinal Scale Mfg. Co., Box 151, Webb City, Mo. Bulletin 102 describes line of suspension hopper scales, for batching, charging, proportioning, filling and processing.

Systems—Whitney Blake Co., Tuffline Div., New Haven 14, Conn. Folder describes Tuffline heavy-duty portable electric distribution systems for industrial needs including mines, tunnels and passageways.

Tubing—Bemis Bros. Bag Co., 601 S. 4th St., Dept. M, St. Louis, Mo. Booklet on Flexi-pipe mine and tunnel ventilation tubing includes diagrams on use of pipe for various shaft ventilation systems.

Loader—A. C. Anderson, Inc., Dept. 706, Wildwood, N.J. New Power-Crowd loader that scoops dirt while the tractor is stationary is described in bulletin.

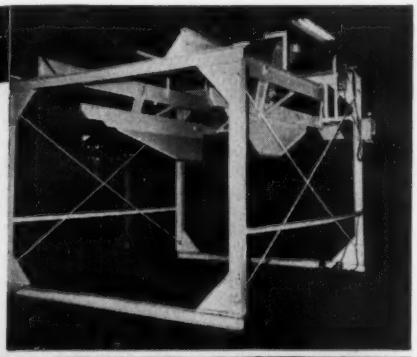
Conveyors—Barber-Greene Co., Aurora, Ill. Catalog describes recently expanded "Redi-Fab" belt conveyor line, including lengths from 18 to 240 ft and capacities up to 480 tph.

Shovel—Thew Shovel Co., Lorain, Ohio. Company just released bulletin on its ¾-yd crawler-mounted Model 26 shovel.

Drives—Link-Belt Co., Prudential Plaza, Chicago 1. "Type RS P.I.V. Variable Speed Drives" is the title of a new 6-p folder on units for capacity demands from 50 hp and ratios up to 5.5:1.

For BIG SAVINGS in Time and Labor Maintenance Expense Installation Cost

Check These Features of the STAMLER Automatic TILT PAN





- It automatically loads entire trip without belt stoppage or spillage between cars.
- It permits use of boom man on productive face jobs.
- It provides uniform car loading without an attendant.
- It can be quickly installed and easily moved.
- It operates with existing car spotters without special hydraulic power units.
- It operates with non-uniform car lengths.
- It is self-adjusting for dented car bodies.
- It automatically shuts down without spillage if the last empty car becomes loaded.
- It fits into the same head room as manually operated flygate chute.
- Fail safe under any emergency.

Get all the facts on the STAMLER Automatic Tilt Pan. Write today for folder.

STAMLER Automatic TILT PANS

SCHROEDER BROTHERS, Exclusive Eastern Sales Agent Pittsburgh, Pennsylvania

UNION INDUSTRIAL CORP., Carlsbad, New Mexico

W. R. STAMLER CORPORATION

PARIS, KENTUCKY

SALMON & CO., Birmingham, Alabama

WESTERN SALES ENGINEERING CO., Salt Lake City, Utah

JOY ELECTRICAL EQUIPMENT for the coal mining industry

Lectronic Sentry

Protects against ground faults and short circuits on all D.C. operated off-track mining machines and trailing cables. Continuous monitoring signal between transmitting and receiving elements is interrupted when trouble occurs, and circuit breaker instantaneously cuts power to machine and trailing cable. *Requires no grounding conductor*, permits use of lower cost 2-conductor cable.

CABLE VULCANIZER

Bench model vulcanizer for fast, safe, economical cable repairing and splicing. Accommodates molds for patching, splicing, special Y splices, T tap-offs, etc. Vulcanized area is as watertight, flexible and permanent as original cable covering. Includes temperature selector for both platens, pressure regulators up to 25 tons. Handles molds up to 6" wide, for cable up to 5" in diameter. Can be used in tandem for extremely long splices. Available for standard factory voltage, A.C. or D.C. Portable model also available.

CONNECTORS

Hi-Voltage Type

Multiple conductor high voltage connectors are designed for operation up to 7500 volts. Each unit is fabricated in two stages; (1) primary molding securely embeds each contact and conductor wiring junction in highly resistant, void-free Butyl. A (2) secondary molding encloses all contacts inside a resilient Neoprene body and permanently vulcanizes it to its chosen cable.

Straight Pin Bigun Style

With threaded metal couplings for positive engagement and disengagement. Completely watertight when engaged. Molded to 36" leads, or other lengths as specified. Two types of waterseals insure perfect operation, even under water or in dust choked atmospheres.

Quik-Loc Style

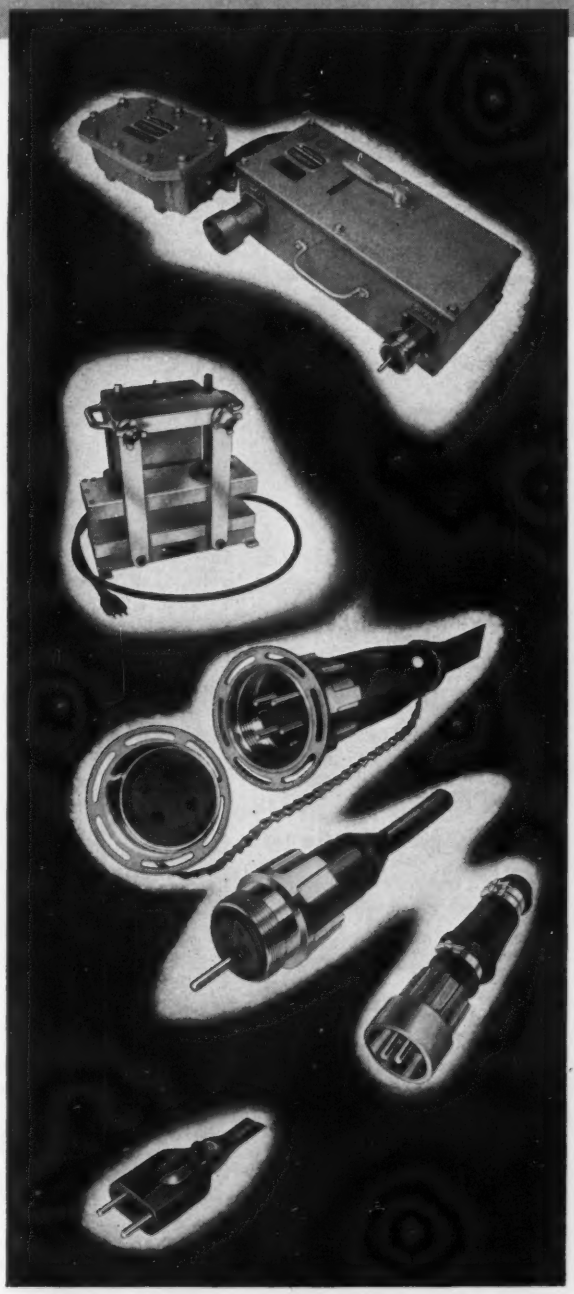
Similar to Straight Pin Biguns, except square cut groves and lead pins are used instead of machine threads. Engage and disengage in ¾ turn. Attach quickly and easily to cable or can be ordered now molded to cable as required.

Oval Style

For general, all-round electrical connection requirements. Lies flat, offers less obstruction. Reinforced at cable-connector junction with taper-neck vulcanization.

For consistent quality and dependable performance, specify Joy electrical equipment specially designed for mining applications.

Insist on the Orange Dot!
the mark of quality



JOY

ELECTRICAL PRODUCTS DIVISION

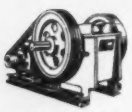
Write for Descriptive Bulletin B73

CD-759.1

1205 Macklind Ave., St. Louis, Mo.
Exec. Offices, Henry W. Oliver Bldg., Pgh., Pa.

The Company that cares enough to give you the best!

Laboratory Equipment



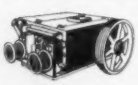
4"x 6" Massco Laboratory Jaw Crusher

Welded steel frame; manganese steel jaw and cheek plates; bronze bushed bearings; smooth jaws give better product and easier cleaning. Adjust for plate wear and product size by convenient hand wheel adjustment.



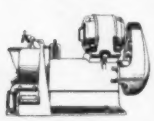
6" and 10" Massco Gy-Roll Reduction Crusher

Reduces ½" feed to as fine as 10 mesh in single pass. High capacity, low power consumption.



Laboratory Crushing Rolls

Sizes (Diameter x width): 8"x 4", 10"x 6", 10"x 8", 12"x 10" and 12" x 12". Adjustable roll space setting up to ¾". Double V-belt drive. Heavy, cast Meehanite frame absorbs vibration, results in long life.



Massco-McCool Pulverizers

Disc type grinder with a planetery movement. No gears. Will grind ¼" to 150 mesh in one pass.



Marcy Pulp Density Scale

Gives direct reading of weight; specific gravity of liquids, pulps, and dry solids; percent solids in pulp. Very accurate. Easy to clean.

MINE AND SMELTER SUPPLY CO.

3800 RACE STREET • DENVER, COLORADO
OFFICES AND AGENTS IN PRINCIPAL CITIES

Among the Manufacturers

William A. Simonds, who hails from Akron, Ohio, has accepted a position with Schroeder Bros. Corp., McKees Rocks, Pa., as a sales engineer for the company's hydraulic and mining equipment products, it has been announced.



Simonds

A graduate of Kenyon College, Mr. Simonds served in the Marine Corps. He has had a wide variety of experience in petroleum sales, working at one time with Standard Oil Co. of Ohio. He will make his headquarters at Bluefield, W. Va., and will be responsible for servicing the coal mining industry in that area.

Peter Ambrosiani has been named general manager of sales for Wilcox Mfg. Co., Raleigh, W. Va., manufacturer of continuous mining machines for thin-vein coal seams.



Ambrosiani

Mr. Ambrosiani is a registered engineer, having graduated in mining in 1938 from Michigan College of Mining and Technology. Until recently he was manager of western mining territories for The Jeffrey Mfg. Co., with whom he had been associated for the past 17 yr. His experience includes technical specialization in mine ventilation sales and engineering throughout North America and as a sales engineer in off-track and continuous-mining equipment in the Appalachian coal fields.

Herbert G. (Pat) Dillon has joined the Lee-Norse Co., Charleroi, Pa., manufacturers of heavy mechanized mining equipment, anounces E. M. Arentzen, president.



Dillon

Mr. Dillon has been chosen to fill the new position of assistant to the president at Lee-Norse. Before coming to the company, Mr. Dillon had been first vice president of McKiernan-Terry Corp., Harrison, N. J.

Robert H. Burgan Jr., formerly general manager, Lutherville Supply & Equipment Co., is the new mid-atlantic regional manager, Davey Compressor Co., Kent, Ohio. He will direct sales and services in Maryland, Virginia, Delaware, southeastern Pennsylvania and southern New Jersey on the entire Davey line, including compressors, air tools and rotary drills.

Donald C. Riblet has been promoted to manager of the Birmingham, Ala., district office for P&H construction and mining equipment made by Harnischfeger Corp., Milwaukee. For the past year he has been a sales representative Mr. Riblet is a native of Cleveland, Ohio, and holds a degree in industrial engineering from the University of Florida. His territory will include all of Alabama, middle and eastern Tennessee and the western panhandle of Florida.

The Best Wood Tanks

FOR OVER NINETY YEARS

Cypress—Fir—Redwood—Yellow Pine

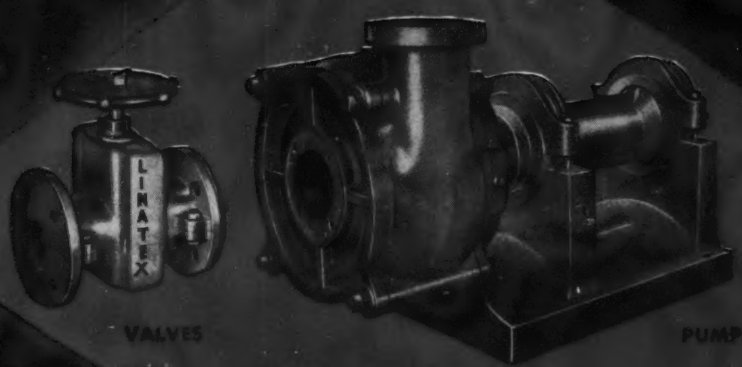
ANY SHAPE—ANY SIZE

The Hauser-Stander Tank Co.

CINCINNATI 32, OHIO

LINATEX®

LASTS LONGEST

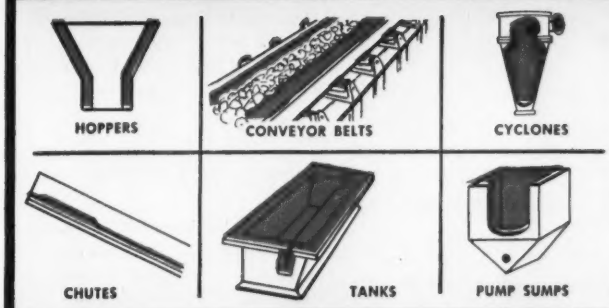


CUT COSTS

NOW-LINATEX

DEFEATS ABRASION AND CORROSION IN MINING-EVERYWHERE!





TYPICAL DOLLAR-SAVING APPLICATIONS

Complete information on Lining with LINATEX: Specific recommendations for your particular problems: representative in principal areas: or

Write for additional Information

LINATEX

CORPORATION OF AMERICA

P.O. DRAWER "D" STAFFORD SPRINGS, CONN.

Manufacturers (*Continued*)

Winston MacPhail is a field representative for Le Roi Div., Westinghouse Air Brake Co., Milwaukee, Wis. He will cover the southern part of the east-central region, consisting of Kentucky, West Virginia, Indiana, Ohio, western Pennsylvania and lower Michigan.

John R. Mills has been appointed sales manager for the Rota Drill Div. of Schramm, Inc., West Chester, Pa., manufacturer of air compressors and air drilling equipment. Mr. Mills comes to Schramm with over 10 yr of experience in many phases of water-well and blast-hole drilling. He holds a BS in Geology from Franklin & Marshall College and received his MA from Lehigh University while serving as an instructor in its Geology Dept.

Ronald R. Blevins, formerly manager of Joy Mfg. Co.'s Norton, Va., warehouse, has been appointed a sales engineer for Joy coal machinery, with headquarters at the firm's district office in Huntington, W. Va. Prior to his affiliation with Joy in 1956, Mr. Blevins was a salesman for National Mine Service Co. He replaces **Robert L. Summitt,** who resigned from Joy to join Wise Coal & Coke Co.

Richard K. Teske was named Chicago district manager for Leschen Wire Rope Div., H. K. Porter Co., Inc. He was formerly Michigan territory salesman for Leschen. His district includes all of Indiana, Michigan, Wisconsin, Minnesota, North Dakota and part of Illinois, Iowa and Kentucky. Mr. Teske, 42, is a veteran of 12 yr in the heavy construction and gravel industries.

C. J. Moore, former general sales and marketing manager for Exide Industrial Div., The Electric Storage Battery Co., has been promoted to vice president-marketing, of the division. In his new position he will continue to direct at the highest policy level all national sales and marketing activities for Exide industrial batteries, battery-charging equipment and related components.

James R. Kelly, sales engineer, Wellston Div., The McNally Pittsburg Mfg. Corp., died recently of a heart attack. Mr. Kelly, who was 60, came to McNally in 1946 and was well known among the eastern coal operators.

Allis-Chalmers Mfg. Co. has made several changes in its Industries Group: J. A. Sudduth has been appointed manager, St. Louis district; **R. E. Morris** is the new manager of the midwest region; and **Charles F. O'Riordan** is manager of the north-central region. Also, **William A. Rapp** and **Byron K. Smay** have been named as sales representatives to the St. Louis district.

Briefs

Charles M. Beeghly was elected president, Jones & Laughlin Steel Corp.

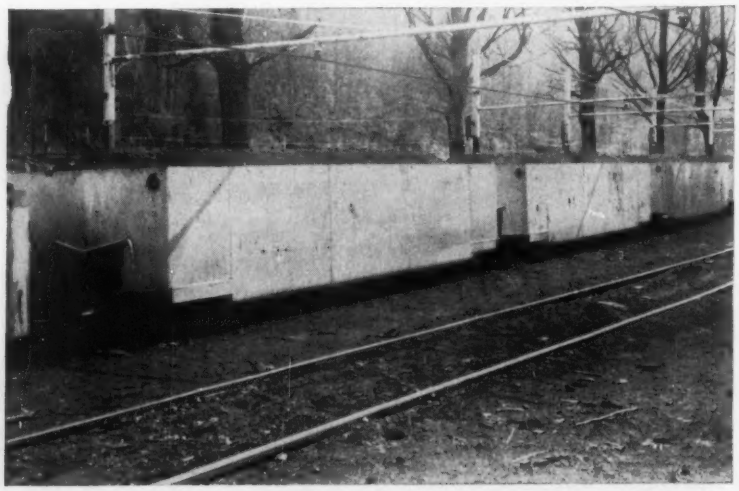
Scandinavia Belting Co. has changed its name to Scandura, Inc.

Albert E. Reed has been named vice president, marketing, for The. W. S. Tyler Co., Cleveland.

J. F. Cronin has been named manager, Mining, Materials Handling & Electrolytic Processes Sales Div., for General Electric's Industrial Commercial Sect.

S. O. Bringhurst has been chosen manager of the Salt Lake City branch of Mine & Smelter Supply Co.

B. R. Putnam has been appointed manager, Explosives & Mining Chemicals Dept., American Cyanamid Co.



haulage capacity...

Place Pocahontas Field

Operator Name on request

Car Dimensions Length: 21′ 6″ (body)
Width: 7′
Height: 48″ (above rails)
Weight: 8600 lbs. (empty)

Capacity 500 cu. ft. (level load)
585 cu. ft. (crown load)

where can you match it?

Since 1915 — Pioneers in haulage equipment

DIFFERENTIAL STEEL CAR COMPANY
FINDLAY, OHIO

SPECIAL REPORT TO CATERPILLAR OWNERS:

CAT CATERPILLAR

Parts you can trust
... cost less per hour

Converting to Lifetime Lubricated Track Rollers costs less than you think

Lifetime Lubricated Roller Groups, including seals, shafts and end collars, *cost only a little more* than ordinary Bellows Seal Rollers without end collars. But this small expense of *initial* installation rapidly disappears through noticeably lower owning and operating costs.

Based on savings from seal replacement alone, Lifetime Lubricated Rollers soon make up the difference. The metal rings of the Floating Ring Seal can be used over and over again. Take a 14-roller D8. At every roller rebuild, you probably have to buy 28 bellows seals @ $3.97* each or a total of $111.16. Compare this with the rubber "O" rings costing a total of only $45.08*. You save $66.08 in seal replacement costs every time you rebuild or replace. Similar savings are available on all models. And, replacement Lifetime Lubricated Roller and shaft assemblies without end collars are priced below those of Cat Bellows Seal Rollers.

But your savings don't end here! Here are other benefits you get from Lifetime Lubricated Track Rollers:

1. Longer Lived Roller Shells and Component Parts. The Lifetime Lubricated Roller is much stronger and has more metal in the wear zones, specially hardened for extra resistance to wear. And bushings, bearings and shafts are larger and stronger and will last longer. These components are *always* bathed in *clean,* heat-dissipating oil (not grease). Dirt just can't get in to accelerate wear—oil can't get out, thanks to the patented Floating Ring Seal. This means you won't be buying as many replacement bushings and shafts at rebuild or roller replacement time.

2. Maintenance Is Eliminated. Lifetime Lubricated Rollers need no servicing until they're finally rebuilt. You don't have to spend any time nor money for lubrication during the rollers' lives.

3. Easier Installation. Snap-on rings hold seals and end collars in place *before* mounting. End collar bolt holes line up easily with track roller frame holes at installation. Your tractors will be on the go much sooner.

See your Caterpillar Dealer. He'll give you the complete facts on the economy of investing in Lifetime Lubricated Rollers . . . for *all* Caterpillar track-type equipment.

Caterpillar Tractor Co., General Offices, Peoria, Illinois, U. S. A.

*Suggested consumer prices for these Caterpillar parts

SERVICE TIP: Lifetime Lubricated Rollers need no servicing. But when rebuild time finally comes, keep metal rings matched in original pairs.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

Open Pit Mining Association

(Continued from p 121)

mended. Each of the grounds should have low resistance, preferably less than 2 ohms for the main substation and less than 5 ohms for the safety ground.

Principles of Modern Control for Large Excavators, Prof. Charles Siskind, school of electrical engineering, Purdue University, W. Lafayette, Ind.

Controls for modern electrically powered excavators are based on controlling the speed of electric motors. There are two ways: (1) by changing the voltage across the armature field and (2) by changing the flux.

Two new control systems used on modern excavators are the Amplidyne in which the operator controls a small electrical current to maneuver a very large machine, and the Rototrol which is a magnetic amplifier. Continuing development of those controls can be expected because they perform an excellent function.

Starting with the diagram for a simple motor-generator, Prof. Siskind then sketched diagrams and curves on a blackboard to show how field coils and limiting devices are employed to build up a control for a modern shovel.

Idea Forum

Report on Electrical Equipment Storage Progress, R. M. Leseney, master mechanic, Truax-Traer Coal Co., Fiatt, Ill.

A start has been made in improving the facilities and methods of storing electrical equipment. Some of the suggestions include making the storage room as small as possible but not overcrowded; preventing moisture from reaching the equipment; and providing a thermostatically controlled heated room throughout the year.

Power Failure Protection for Large Excavators, R. T. Taylor, electrical engineer, Peabody Coal Co., St. Louis, Mo.

A power failure is critical when it occurs during any part of the shovel operating cycle. One idea employed to prevent trouble when a power failure occurs during the cycle is application of over- and under-frequency relays to set the brakes on a stripping unit.

If a power failure occurs the relays set the brakes automatically, an action which is easily heard by the operator. He is thus warned of the power outage and can quickly apply dynamic braking to stop the machine as quickly as possible. Potential shovel damage can thus be prevented. This type of protection is particularly desirable on large machines.

A Commutating Problem, J. C. Rettenmayer, chief, electrical engineering, The United Electric Coal Cos., Canton, Ill.

Our company had a brush problem and a wheel excavator which resulted in brushes wearing out in less than a week. We checked closely to locate the cause but had difficulty finding the trouble.

It was suggested to us that perhaps the brushes were underloaded. We followed this lead and removed some of the brushes, which solved the problem.

In explaining this type of problem Mr. Walter Helwig noted that if brushes are not fully loaded friction increases, the brushes bounce around and selective loading follows. For good operation, brushes should carry 60 amp per square inch.

Mercury Vapor Flood Lighting for Strip Excavators, T. Elmer Davis, electrical engineer, Stonefort Coal Mining Co., Inc., Stonefort, Ill.

We have installed one mercury vapor light on each side of the revolving deck and they have proven so successful that the machine operator says he would not like to be without them. They have been in service since December, 1958, and have given no trouble after 4,000 hr of service. Life expectancy is about 7,000 hr.

Another light was installed on the A-frame where considerable trouble had been experienced with conventional lighting and it has proven satisfactory.

Among the benefits of the vapor lighting are good visibility, ability to distinguish between coal and rock and effective lighting in fog and dust. A 400-W vapor light provides the same intensity as a 3,000-W incandescent light.

Preparation for Parking of Equipment, Richard Stokes, electrical engineer, Lynnville mine, Peabody Coal Co., Lynnville, Ind.

We have had to mothball a large shovel because of a change in development schedule. This work included covering all electrical components with polyethylene sheets which make visual inspection possible. All bearings were flushed and filled with rust-inhibiting oil. The main m-g set, also covered with polyethylene, has a 2-kw natural convector electric heater near it and other heaters are strategically located in the shovel. Equipment is meggered every month and the tests indicate that the mothballing system is working.

Next month *Coal Age* will publish a description of how one coal company constructs permanent barricades underground to provide emergency shelter for workmen in producing sections.



Maintenance Tip No. 3

PROPER APPLICATION OF SCREEN SECTIONS

When installing a vibrating screen section, be sure it is centered and aligned. Take up tension from both sides of the vibrator to maintain centered position and keep hooked edges from deforming — exam circle above. Tension or pull must be horizontal to prevent whipping or slipping of screen sections. Check the application carefully. Call Cleveland Wire Cloth for valuable assistance and top quality vibrating screen section cloth.

Write for ***FREE*** maintenance-reducing check sheet today.

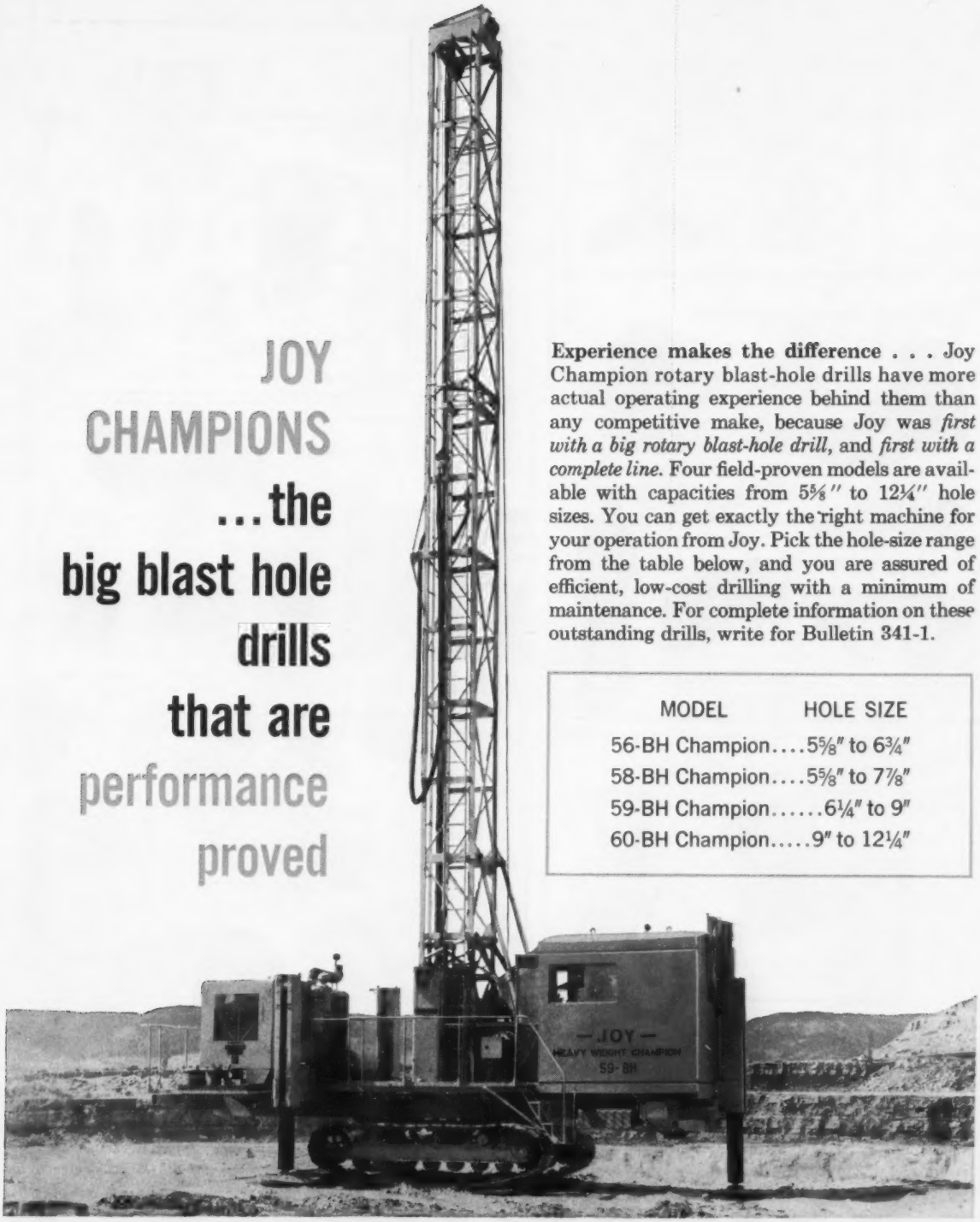
THE CLEVELAND WIRE CLOTH & MFG. CO.

3572 EAST 78th STREET , CLEVELAND 5, OHIO

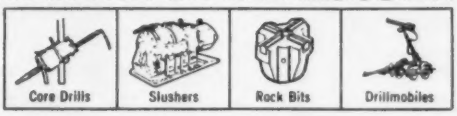
JOY CHAMPIONS ...the big blast hole drills that are performance proved

Experience makes the difference . . . Joy Champion rotary blast-hole drills have more actual operating experience behind them than any competitive make, because Joy was *first with a big rotary blast-hole drill*, and *first with a complete line.* Four field-proven models are available with capacities from 5⅝" to 12¼" hole sizes. You can get exactly the right machine for your operation from Joy. Pick the hole-size range from the table below, and you are assured of efficient, low-cost drilling with a minimum of maintenance. For complete information on these outstanding drills, write for Bulletin 341-1.

MODEL	HOLE SIZE
56-BH Champion	5⅝" to 6¾"
58-BH Champion	5⅝" to 7⅞"
59-BH Champion	6¼" to 9"
60-BH Champion	9" to 12¼"



EQUIPMENT FOR MINING... FOR ALL INDUSTRY



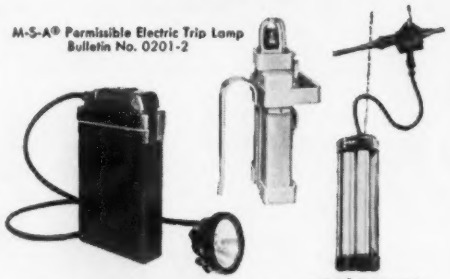
JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

ILLUMINATION

M-S-A® Permissible Electric Trip Lamp
Bulletin No. 0201-2



New Edison Model S Electric Cap Lamp
Bulletin No. 0201-6

M-S-A® Permissible
Mine Lighting System
Bulletin No. 0201-4

PERSONAL PROTECTIVE WEAR



M-S-A® Footwear
Bulletin No. 1303-3A



M-S-A® Work Gloves
Bulletin No. CF-30



M-S-A® Safety Belts
Bulletin No. 1302-3

M-S-A® CHEMKLOS®
Bulletin No. 1309-1



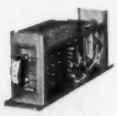
M-S-A® Goggles
Bulletin No. 0301-8



M-S-A® Eye Shields
Bulletin No. 0302-3



COMMUNICATIONS





M-S-A® Transistorized Audio Tone Transmission
Equipment—Bulletin No. 1600



M-S-A® MinePhone*
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M-S-A® Mine Rescue Communication System
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ARTIFICIAL RESPIRATION



M-S-A® PNEOLATOR®
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M-S-A® H-H Inhalator
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M-S-A® Model 2100
Mine Fire Truck
Bulletin No. 1203-3







M-S-A® Model 1000
Mine Fire Truck
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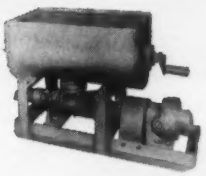
M-S-A® Mine Fire
Control Dry Chemical
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M-S-A® Mine Fire Hose Bulletin No. 1203-2

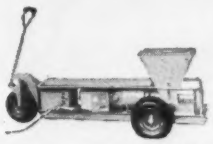
Miners work safest, operators get greater tonnage with

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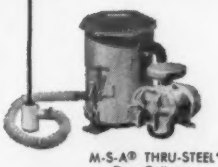
M-S-A® Model 80 Slurry Rock Dust Distributor—Bulletin No. 1201-6



M-S-A® Bantam 400 Rock Dust Distributor Bulletin No. 1201-2



M-S-A® Slurry Rock Dust Distributor Bulletin No. 1201-4



M-S-A® THRU-STEEL* Dust Collector Bulletin No. 1207-1

RESPIRATORY PROTECTION



M-S-A® Self-Rescuer® Bulletin No. EC-1



M-S-A® Dustfoe® 66 Respirator Bulletin No. 1004-3



M-S-A® CHEMOX® Breathing Apparatus Bulletin No. B-14

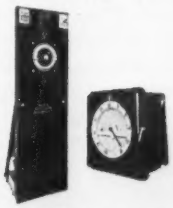


M-S-A® McCaa® Two-Hour Breathing Apparatus Bulletin No. BB-3

METHANE DETECTION



M-S-A® Methane Alarm Bulletin No. 0809-2



M-S-A® Methane Recorder Bulletin No. 0706-1



M-S-A®-Wolf Junior Flame Safety Lamp Bulletin No. 0807-1

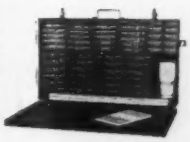


M-S-A® Methane Detector Type W-8 Bulletin No. 0809-4



M-S-A® Methane Tester Type M-6 Bulletin No. 0809-3

FIRST AID EQUIPMENT



M-S-A® Miner's First Aid Cabinet Bulletin No. 0401-2



M-S-A® Jenkins Stretcher Bulletin No. 0408-10

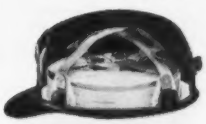


M-S-A® Emergency First Aid Outfit Bulletin No. 0408-10



M-S-A® Unit First Aid Kits Bulletin No. 0401-2

HEAD PROTECTION WITH FIXED-CROWN* SUSPENSION



M-S-A® Comfo Cap® Bulletin No. 0601-3



M-S-A® Type K SKULLGARD® Hat Bulletin No. 0601-4

PORTABLE INSTRUMENTS



M-S-A® Portable Oxygen Indicator Bulletin No. 0817-1



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See why ALCOA ALUMINUM makes a good design habit

Requirement: a low-cost metal to reduce corrosion-caused maintenance and replacement in mining operations

Key to good design: specify corrosion-resistant Alcoa Aluminum for structures, piping and equipment

The cost of equipment and maintenance often makes the basic difference between profit and loss in mining operations. Add to this the fact that mining operations generate a variety of strongly corrosive fluids and gases capable of eating through most metals in a dishearteningly short time. The clear need is for a metal able to offer superior resistance to such corrosive attack while providing a reasonable initial cost. The clear solution to the problem is aluminum . . . ALCOA® Aluminum.

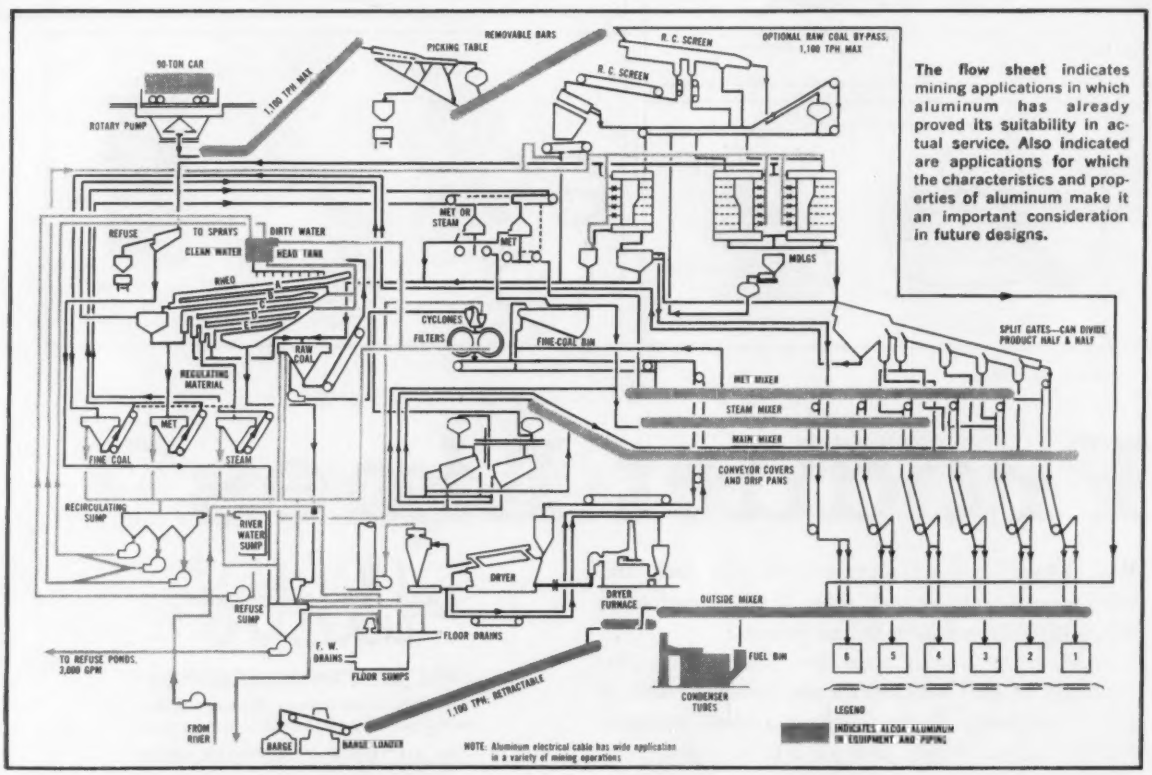
Aluminum is the only metal able to offer reliable resistance to the major types of corrosive attack encountered in mining. The degree of that corrosion resistance can be predicted with substantial accuracy in each instance—based on an accumulation of ALCOA service data representing over 40 years of aluminum experience in mining. Thus, it can be demonstrated that aluminum assures the longest service life in applications ranging from mine service piping to trucks, hopper cars, instrument and air line tubing, grating and tread plate, or building siding and structurals.

Add to the advantages of aluminum in mining these benefits: low friction loss of head in piping to maintain head pressures with no increase in pumping capacity . . . remarkably low initial cost when compared to other commonly used metals . . . light weight for handling ease and installation economies.

The combination of cost and service benefits offered by aluminum make it a natural choice for the varied mining applications shown and described on these pages —and for a host of others. A great deal of supporting performance data stands behind all of these successful uses of aluminum. ALCOA engineers are anxious to share with you their accumulated experience in mining. They are doing so through a series of engineering conferences being held in major cities around the country. Your nearest ALCOA sales office will furnish details.

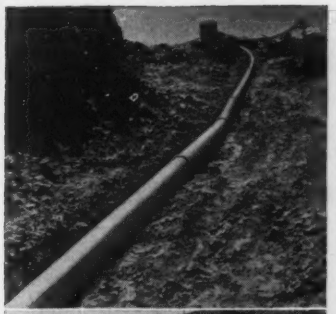
You may also wish to avail yourself of the large body of ALCOA literature which describes in technical detail the known performance characteristics of aluminum in a variety of applications. Simply fill in and mail the coupon.

World wide sales through ALCOA INTERNATIONAL, INC., 230 Park Avenue, New York 17, N.Y.



Truck bodies of Alcoa Aluminum have proved able to provide valuable economies in mining operations. Their light weight helps to make possible higher payloads without increase in axle loading. The strength of the aluminum alloys used in this service insures excellent physical durability, and their great corrosion resistance and weathering characteristics contribute to long service life. Initial cost is surprisingly low.

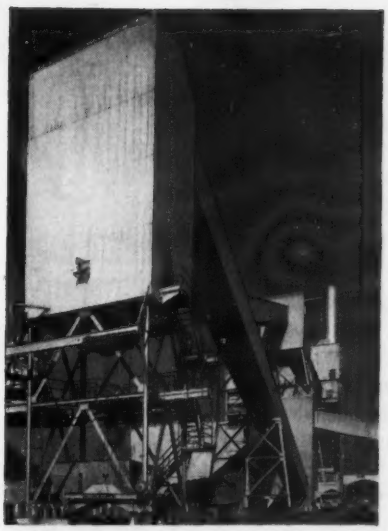




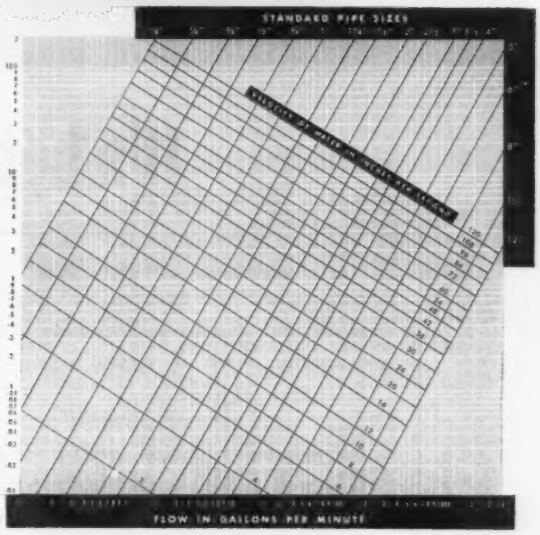
Water, air and drainage lines make good use of a variety of aluminum advantages—in addition to its corrosion resistance. Light in weight, aluminum pipe is portable, easy to string in confined spaces . . . with small crews for installation economy. And thin-walled aluminum pipe for this service is low in initial cost, strong enough to permit pickup and re-laying when necessary.



Conveyor covers of corrugated aluminum deliver excellent service life at low initial cost with little or no maintenance. Their light weight frequently permits less costly supporting structures, too. And aluminum drip pans beneath the belts help to make the entire conveyor system more resistant to corrosion and subsequent breakdown.



Corrugated roofing and siding of Alcoa Aluminum has proved ideal for a variety of mine buildings and equipment housings. It provides outstanding resistance to the attack of corrosive atmospheres. Light and easy to handle, it can be installed most economically. Maintenance is negligible.



Aluminum pipe's low friction factor means less loss of head as shown in this chart. As a result, aluminum offers the important benefit of helping to maintain satisfactory head pressures without excessive pumping costs.

Aluminum Company of America, 878-G Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries:

- ☐ 10197 Aluminum Pipe and Fittings
- ☐ 10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
- ☐ 514 Alcoa Duotrace Technical Report
- ☐ 10270 Alcoa Utilitube
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 11453 Solving Refinery Corrosion Problems with Aluminum
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
- ☐ 19416 Brazing Alcoa Aluminum
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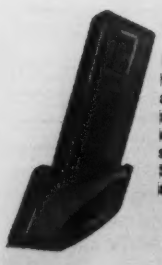
"If you deal with the lowest bidder, it is well to add something for the risk you run. And if you do that you will have enough to pay for something better."

John Ruskin

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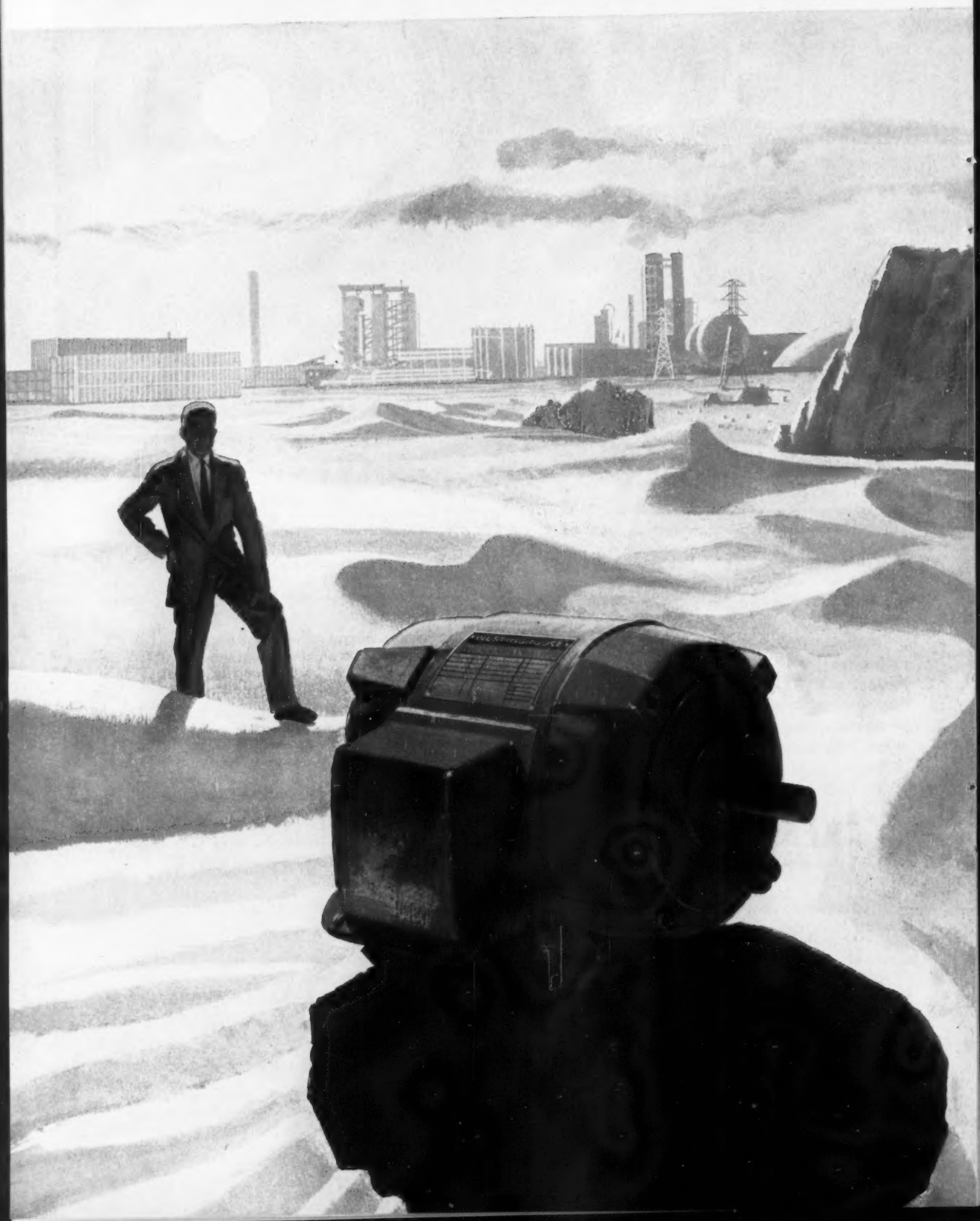
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THE MAN & THE MOTORS



FROM WESTINGHOUSE

Guardistor motors let you match the full capability of the motor to the job— with complete safety—absolute confidence

Our Marketing Manager says:

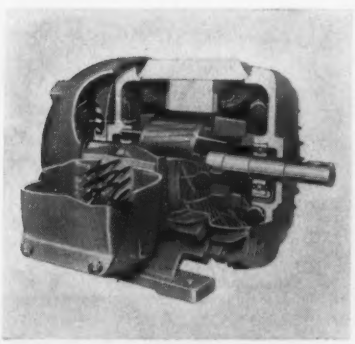
- "You can match the motor to the load . . . use all the motor you are paying for.
- Provides positive protection based on winding temperature . . . *not* load current and/or power supply fluctuations.
- Eliminates time and expense of changing winter-summer heaters. No nuisance tripping, it's fail-safe . . ."

Our Engineering Manager says:
"With the breakthrough development of the Westinghouse Positive Temperature Coefficient thermistors, for the first time we can provide inherent protection against motor failure caused by excessive heat. The solid-state thermistors buried in the windings instantly sense excessive heat from any cause and simultaneously warn of trouble or automatically take the motor off the line. Thus, motor protection is placed where only true motor protection can be . . . in the windings."

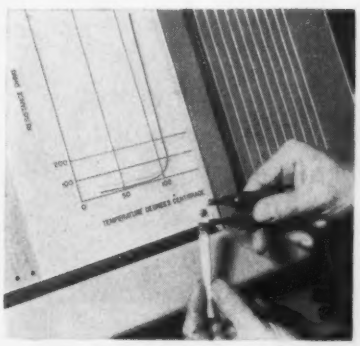
Call your Mr. Westinghouse for the application of a Guardistor* motor to your drive requirements . . . write for *Questions and Answers About . . . Guardistor* (B-7876). Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

*Trade-Mark

J-22160



Unlike remotely located sensing devices, PTC thermistors are buried in the windings of the Guardistor motor, instantly equating all temperature factors.



Ever alert PTC thermistors constantly totalize temperature, statically triggering an action *only* if critical temperature is reached.

MOTOR & GEARING DEPARTMENT

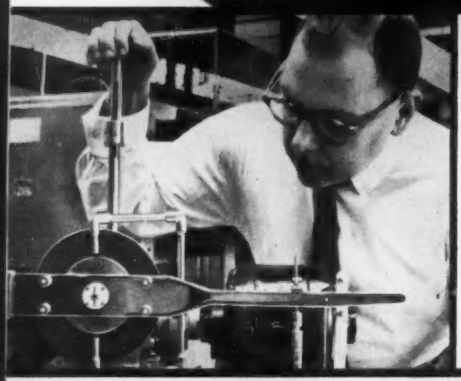
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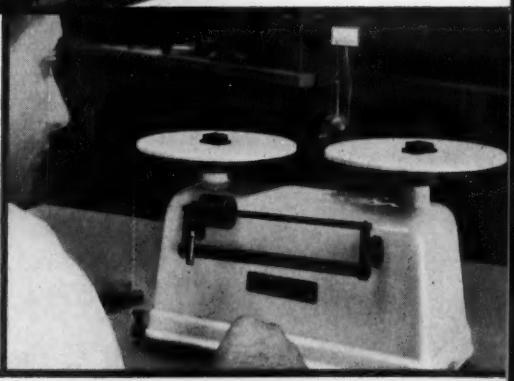
Make the test where





Circle laboratory technologist conducts an abrasion test on a sample of neoprene cable sheathing which must perform well within minimum tolerances.

Weighing of samples after comparative abrasion test shows how Circle cable sheathing has abraded considerably less than competitive brands.



it counts...
in the mine!

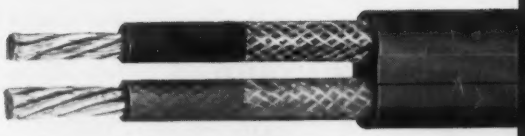
Comparative tests confirm the long life and outstanding performance of Circle mining machine cables.

Laboratory tests as well as in-the-field service records prove Circle mining machine cables outlast, outperform ordinary cables in resistance to abrasion and tear—last from weeks to months longer on the job.

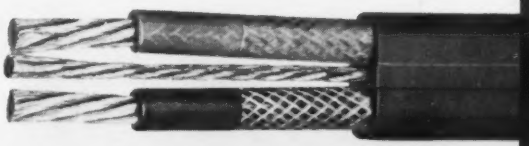
The reason for this is the specially compounded, unusually tough neoprene jacket that seems indifferent to the brutal beating all cable takes in a mine.

Special compounding techniques plus careful mold curing team up to give this Circle protective sheath its unusual toughness. The compounding involves a unique blend of various carbon blacks with other ingredients that enables Circle to obtain an optimum balance of properties in the cable jacket. Mold curing locks these properties in for maximum performance in the field.

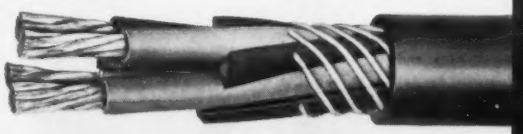
Why not test a Circle mining machine cable alongside the brand you're using now. See first hand how Circle cables give you longer life for your cable dollar. Next time you order cable, specify Circle.



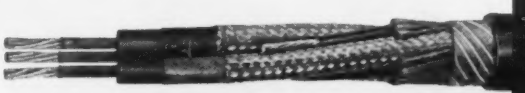
FLAT TWIN PORTABLE POWER CABLE, Type W 600 V—Normally used on track-mounted coal-cutters, loaders, etc. Flat shape resists crushing, allows easier coiling on take-up reels. Recommended maximum voltage: 1000 V.



FLAT TWIN PORTABLE POWER CABLE, Type G 600 V—Used for machines with pneumatic tires requiring vehicle frame to be maintained at ground potential. Any other application where grounding conductor is required. Recommended maximum voltage: 1000 V.



THREE AND FOUR CONDUCTOR MACHINE CABLE, Type W and Type G 600 V—Used for air conditioning apparatus, portable welding machines, dredges, and other types of portable equipment. In hazardous applications where grounding is required, Type G is preferred. Recommended maximum voltage: Type W—3000 V; Type G—5000 V.



SHOVEL CABLE, Type SH-D 2000 V to 15,000 V maximum—For electric shovels and other portable machinery with high voltage circuits. Shields on individual conductors provide protection to personnel, protect against corona. Ground wires are sufficiently large to assure positive grounding of equipment frame.

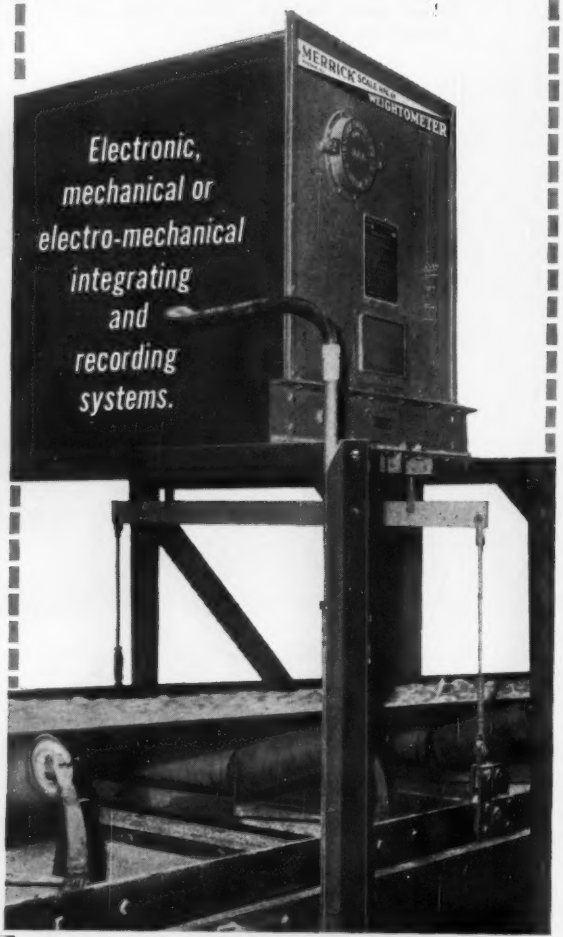


LOCOMOTIVE OR TRAILING CABLE, 600 V—Used primarily as trailing cable for mine locomotives operating beyond limits of trolley wire. May also be used as a motor lead cable.

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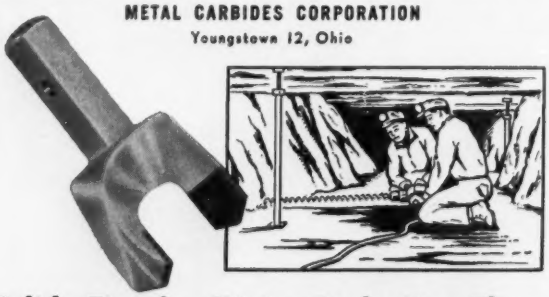
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SUPERSET CORE BITS



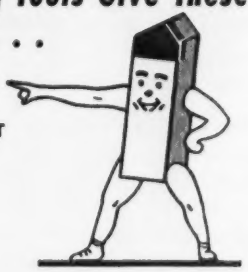
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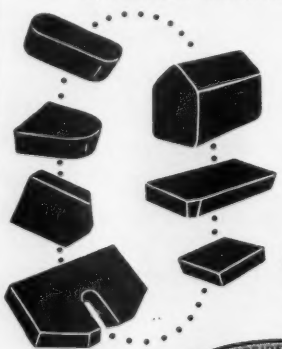
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Youngstown 12, Ohio



Talide Tips for Mining Tools Give These 3 BIG ADVANTAGES . . .

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2. SUPER HARD
3. SHOCK RESISTANT





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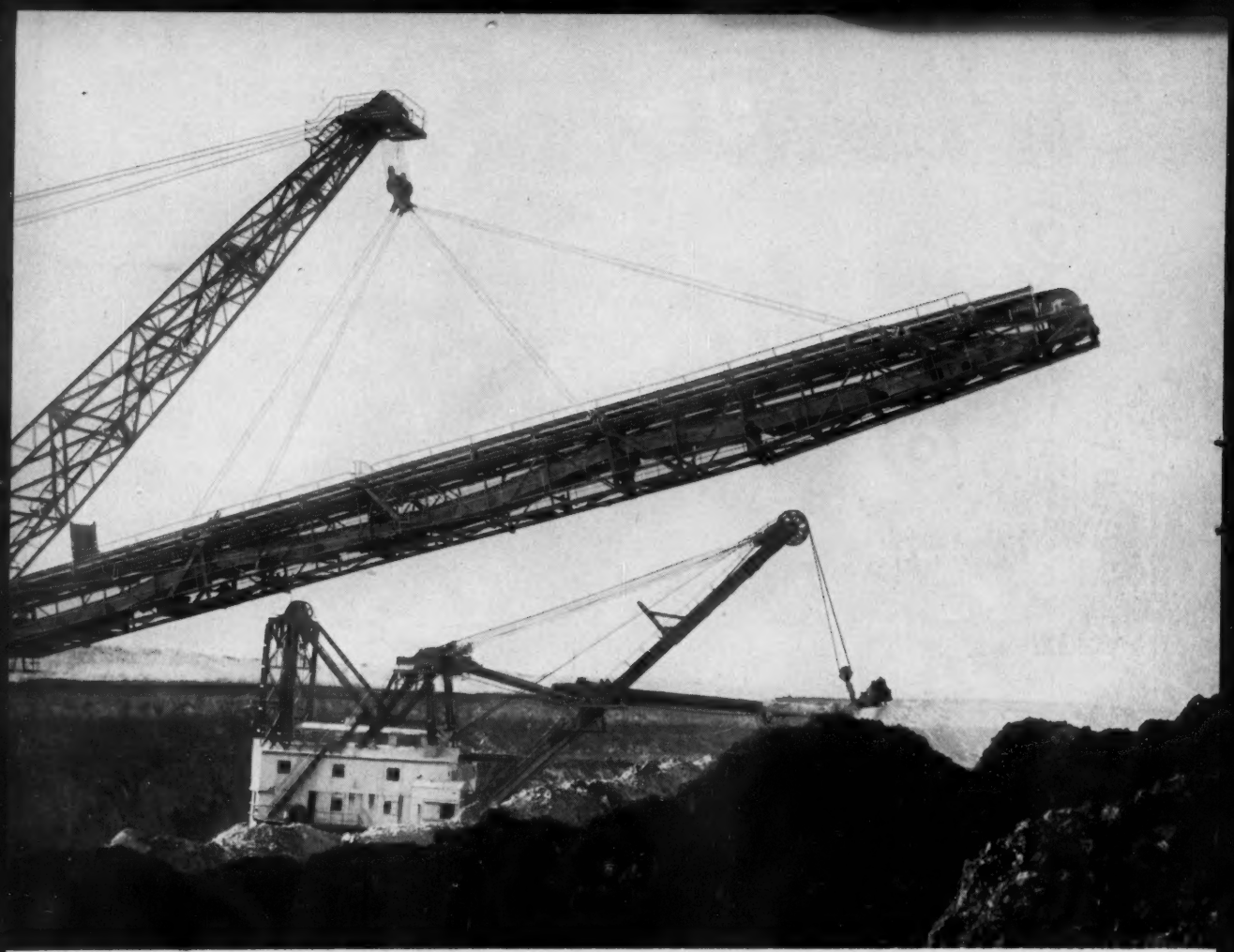
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JOY EQUIPMENT SELECTOR CHART

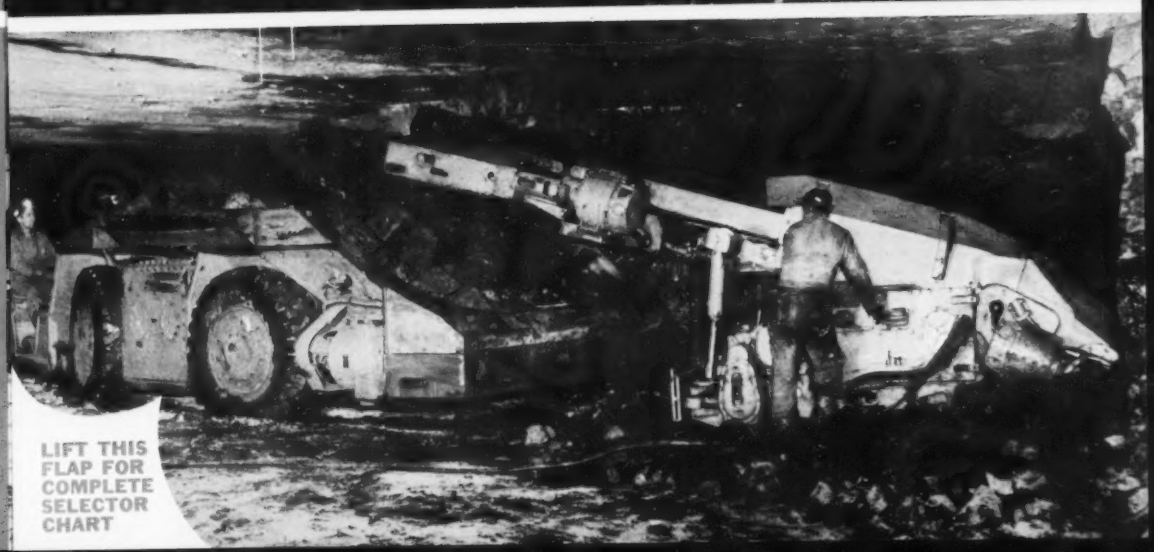
LOW SEAMS



MEDIUM SEAMS



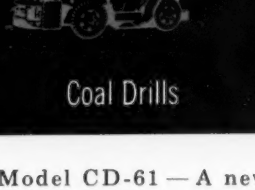
HIGH SEAMS



LIFT THIS FLAP FOR COMPLETE SELECTOR CHART

JOY AC

EQUIPMENT is available for AC or DC Operation

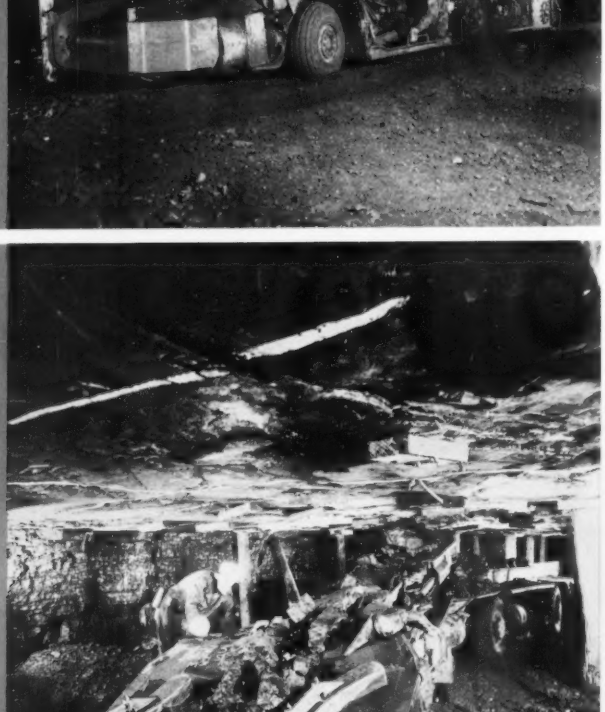


Coal Drills

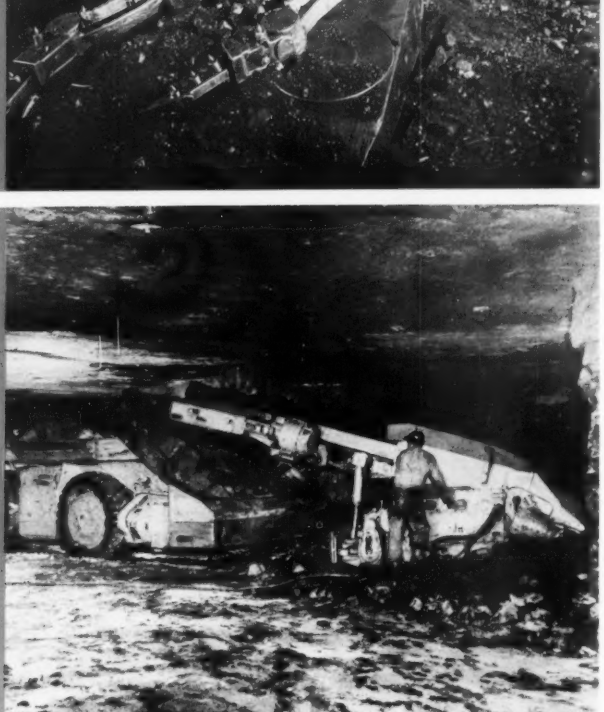


Coal L

LOW SEAMS



MEDIUM SEAMS



HIGH SEAMS



Model CD-61 — A new rubber-tired hydraulic coal drill for seams as low as 31″. Total machine height—24″.

Model CD-26—Rubber-tired self-propelled drill for seams 37″ and higher. Total machine height—30″.

Model CD-41—A high-performance drill available in three heights for low and medium coal. Machine heights of 34″, 43″ and 47″.

All models mount the powerful CD-40 drill unit. With a 10 to 12 foot auger and feed, most holes can be drilled in one minute without stopping to add auger sections.

All machine functions of tramming, positioning and drilling are controlled from the operator's station. He remains 18′ away from the face and rotating auger. Dual controls permit operation from either side. There is no manual hole spotting—spring loaded pick points and the feed mechanism lock the drill against the face and drilling begins immediately.

The low seam model, 34″ high, can drill horizontal holes 16′ apart without repositioning the machine. The 43″ model can drill a 19½′ face with heights up to 10′6″.

Model CD-42—This unit mounts two identical drills, each independently controlled by its own operator. Simultaneous twin drill penetration and a 21′ horizontal drilling range give the CD-42 a high production capacity. Standard vertical range is 10′6″ and an extended boom can boost the top range to 14′1″.

Model CD-43—A single operator controls twin drills on the CD-43 from a master control panel. While one drill penetrates to blasting depth he positions the second drill and starts it drilling. The operator never leaves his seat because all functions are controlled from the master panel. The drill has a vertical range of 4″ to 10′6″ and a horizontal range of 21′.

Model 14-
HEIGHT—
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Model 14-
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for high seam
limestone, sa

Model 15-B
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New power
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oal Loaders

14-BU-10—24″
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ailable with 24″ wide
r or 30″ wide con-

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d ease of mainte-
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s are easily removed
t. Motors, hydraulic
nd other mechanical
s are mounted out-
machine for easy in-
and maintenance.

14-BU-10—38″
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Reversing conveyor
independent opera-
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s.

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in mines around the
Rated at 5 tons per
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m. A 75 HP main
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seam coal or potash,
e, salt and gypsum.

15-BU-2—This 71″
s designed for 15 to
s per minute in
-high and high coal.
wer increases ton-
d swing-out service
nake inspection and
ance easy. All parts
g service are easily
from the outside.



Coal Cutters

Model 12-RB—A cutter specifically designed for low seams where universal cutting action is not required, the 12-RB is a bottom cutter with limited cutter bar roll for use in seams as low as 30″. Although the machine is only 26″ high, this is a heavy-duty cutter that makes a full 30′ wide bottom cut. Completely field proved in widespread operations, the 12-RB has brought new efficiency to low seam mines.

A top cutter model, the 12-RT, is available for low seams with roof problems.

Model 11-RU — A completely universal cutter only 31″ high for medium-low coal. Top cuts, bottom cuts, shears or anything in-between. Cuts from 10″ below floor to 64″ above, across a 30′ face. Now available with four-wheel traction.

Model 10-RU—The workhorse cutter of many mines. Completely universal action for all heavy-duty cutting from 5″ below bottom to 7½′ above floor. Machine height is 41″. Available with four-wheel drive.

Model 15-RU—A heavy-duty cutter for high-seam, high-tonnage operations. This powerful machine top cuts at 8½, 9½, or 10 feet. The 9-foot cutter bar is driven by an electric motor rated at 75 HP continuous at 75°C rise. Tramming is powered by 30 HP motor for fast moves. Available with four-wheel traction. Because of rugged construction the 15-RU is especially suited for potash, salt, gypsum and soft limestone.

The standard 15-RU is 42″ high. Two additional models are now available. The "low 15-RU" is only 36″ high but has all of the basic rugged construction of the higher model, and the same universal cutting ability. A 15-RB or RT are available as machines of standard height but with limited roll for use as non-universal top or bottom cutters.



Shuttle Cars

Model 18-SC-7—A 24″ car for seams as low as 30″. Revolutionary 6-wheel design uses two center wheels for traction and four corner wheels for steering. Wide (56″) conveyor gives the car 125 cu. ft. capacity without sideboards.

Model 8-SC—A conventional shuttle car for low seams—machine is only 26¾″ high, yet carries a 2 ton payload. Has 5¾″ of ground clearance for fast haulage over rough bottom.

Model 18-SC-1—A 27″ version of the 6-wheel shuttle car. Width of 138″ permits a 72″ conveyor and 180 cu. ft. capacity.

Model 18-SC-2—A 32″ 6-wheeled car with 155 cu. ft. capacity. Two additional models are available with varying machine and conveyor widths to suit seam conditions.

Model 16-SC-4—An extremely rugged car for medium-low seam service. With basic height of 33″, has 130 cu. ft. capacity without sideboards. Trams at 4.5 MPH empty; 4.0 MPH fully loaded.

Model 16-SC—This rugged 4-wheel car is designed to operate under heavily loaded conditions and steep grades. Extra-heavy wheel-drive units and a new frame and body make this 34″ car especially suited for medium-low operations.

Model 10-SC—A rugged, heavy-duty unit for thick seams, the 10-SC is available in 43″, 49″ or 55″ basic heights. This 4-wheel car can haul a 10-ton load at 4.2 miles an hour and discharge in 40 seconds. Can tram fully loaded up a 15% grade.

Model 15-SC—A true high-tonnage car, the 15-SC hauls 15 tons in one load. Designed to work with the 15-BU loader, this 57″ car has two 2-speed, 25 HP traction motors, one for each side of the car.



Continuous Miners

Model 5-CM — A field-proved miner 32″ in height for high production in medium-low seams. Delivers 4 to 5 tons per minute. High tonnage comes from a 42″ wide ripper head that sumps 24″ into the coal.

Model PBM-1—Joy's completely automatic push-button miner for highwall recovery work. A boring-type continuous miner enters the coal, followed by an extensible conveyor system. The entire operation is controlled above ground and a sensing device causes the miner to follow the coal seam. The PBM-1 bores to depths of 1000 ft. or more without any personnel going underground.

Model 1-CM—Designed for seams 52″ and higher, this ripper miner has a capacity of 4 tons a minute. Mounting a 4½′ ripper bar, the 1-CM reaches up to 90″ above the floor to rip a 42″ wide cut. Can operate in rooms 12 to 19′ wide; turn a 14′ crosscut 90° from a 14′ room.

Model 6-CM — A high-capacity ripper type miner rated at 5 to 5½ tons per minute. Will mine rooms 12 to 22′ wide without adjusting or repositioning the machine. Can mine any seam from 5½ to 10′ high without changing or adjusting parts. This extreme flexibility makes the 6-CM ideal for all phases of mine development. An independent gathering arm cleanup can load the conveyor while shuttle cars change.

Model 2-BT-2—The Joy Twin Borer, a full-face boring miner for 6 to 8′ seams, does any job underground—development work, driving entries, headings, mining rooms and extracting pillars. The boring arms and top trimmer chain give excellent roof control with arched sides and a smooth roof. The top trimmer chain can be adjusted instantly while mining to follow variations in seam height.

In renewal parts . . .

JOY HAS THE EQUIPMENT YOU NEED



JOY'S MOTOR REPLACEMENT PROGRAM KEEPS YOUR EQUIPMENT IN SERVICE

Joy now maintains a customer-tailored motor inventory plan to save you dollars and precious time with MRP . . . Motor Replacement Program. MRP makes it unnecessary to tie up inventory dollars in stock motors. Based on past usage and predicted future use, Joy will work out your regular motor needs and stock motors of 15 HP or less in warehouses in your area. MRP keeps your equipment at top performance and drastically reduces down-time.

EXCHANGE YOUR WORN-OUT HYDRAULIC PUMP

A new program of stocking rebuilt pumps now enables you to exchange your worn-out hydraulic pumps for like-new factory rebuilt equipment. Old pumps are cleaned, disassembled and thoroughly inspected. Worn-out parts are replaced and the pump is reassembled, tested, painted and placed in stock for quick delivery to you. Factory parts and factory methods assure like-new performance.

NEW 14-BU CONVEYOR CHAIN . . . 30% STRONGER

This newly-designed 2⅜" pitch chain fits all 24" conveyor machines. Every part of this new chain was designed from experience with the best features of the many chains in Joy's line. New heavy-duty side plates, pins and rivets join the parts into a stronger, more flexible chain. Get new freedom from breakage and up-date your loaders. Fits 14-BU-8, 14-BU-9 and 20-BU without change, fits 14-BU-3, 14-BU-7 and 7R by adding a 2⅜" sprocket.

NEW HEAVY-DUTY RIPPER CHAINS

Joy now has available an expanded line of ripper chains for long, trouble-free performance. The new chains, GV standard pitch and LV short pitch, accommodate the new, wider shank bits developed in cooperation with bit manufacturers.

NEW WHEEL KITS FOR JOY 5, 6 AND 7-SC's

Modernize your shuttle cars. Joy now has a package conversion kit available to bring your older shuttle cars right up-to-date, for more years of service with low maintenance cost. By replacing old wheel units with new 16-SC wheel units you can make your present equipment 53% stronger.



WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

#2065

COAL AGE

JULY 1960

THE MINING GUIDEBOOK

Effective Cost Control ..... p 194

Low-Cost Development for Sustained Efficiency ..... p 201

Continuous Mining ..... p 210

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Equipment . . . . Materials . . . . Services

Effective Cost Control

Basic Approach

Full employment of "industrial engineering" and "operations research" techniques to determine what minimum costs should be and how to attain them.

Key Steps

1. Management acceptance and understanding of the basic principles.
2. Active participation of supervisors.
3. Employment or training of industrial engineers or their equivalent.
4. Allocating to industrial engineering or cost control the rank and authority necessary to achieve the desired results.
5. Adoption of the time-study principle.
6. Methods revision based on time study and analysis of both cycle and equipment.
7. Establishment of standards of performance, with provision for necessary re-study and review.
8. Establishment of incentive-payment plans for foremen or foremen and workers (optional, but commonly accepted as one of the final steps in getting minimum cost).
9. Development of production and delay reports based on standard times or performances, with provision for rating each new section or operation.
10. Adoption of cost and production budgets.

Rewards

Cuts of 25% or more in direct mining costs and up to 50% or more, in a few instances, in face costs. Collateral benefits include ability to forecast costs, plan such operations as haulage to make them better, organize shop work for greater effectiveness, streamline paper work and estimate the effect of nonroutine jobs on costs.

Organizing for Control

FIRST IN IMPORTANCE is understanding of cost control, how it is attained and what it can—and cannot—do. This understanding must be gained by both top and operating management.

Second is incorporation of the foremen into the program on the basis of active participation.

ADDING THE FUNCTION—The two major methods of incorporating industrial engineering cost control into the operating setup are:

1. Establishment of the company's own industrial-engineering, standards or cost control department. If the company is small, the job may fall to the lot of one man—perhaps the superintendent.

2. Contracting the job of setting standards and control systems to an outside specialist.

PROVIDING PERSONNEL — If the company undertakes to handle its own work, the first job is to provide the necessary specialized talent. Perhaps an experienced man or men may be hired. Or they may not be available or the company may prefer to train its own or have them trained. If, as in a small organization, the job falls to one man, he probably will have to be one already on the job and therefore require training.

Whether hired or trained on the job, the preference is for starting with men with mining experience. Their judgment is better when it comes to such things as arriving at a man's "normal" working pace, and they are in a better position to present the new concepts to other operating personnel, and to work with such personnel in getting them applied effectively.

Desirable Qualities—In selecting men for industrial-engineering work, experience has shown that certain personal characteristics are important. They include: ability to lead people and get them to cooperate; understanding of and ability to use mathematical and basic engineering techniques accurately; analytical interest and ability; and the patience and tenacity to see a project through to its conclusion.

Another key element is the understanding and cooperation of the foremen. There is unanimous agreement that they also must understand the aims and objectives in standards-setting, and must be familiar with and able to apply standards-setting principles. Thus, all foremen should be able to make time studies and apply the results.

ORGANIZATIONAL PLACEMENT — Two common approaches to fitting the industrial-engineering function into the organization setup are:

1. Separate status for production and standards, with care, however, to keep standards on an equal plane. This means making industrial engineering a staff or fact-providing function though ranking it in importance with the production function.

2. Allocating to industrial engineering a degree of line or production responsibility in addition to staff status.

Which plan, or modifications thereof, to adopt depends, in the last analysis, on individual circumstances. The goal is to provide the industrial engineering or standards department with the status and authority necessary to insure that its operations pay off. Too much authority can be bad—and also too little.

Time Study

GOALS in industrial engineering and operations research include revision of methods and equipment to attain maximum efficiency and lowest cost, determination of production standards and measurement of actual performance against these standards, establishment of a reporting and accounting systems that will provide an immediate and accurate record of results and facilitate control of cost, and establishment of incentives to stimulate the best efforts of management and men.

The time study is the major tool. It provides the data which are the only sound basis for making a change in methods or equipment, for eliminating bottlenecks, for uncovering hidden delays and for determining work loads as a first step toward reducing or eliminating idle time.

The time study is the only effective basis for the establishment of performance standards. Such standards provide unbiased figures on the production that should be realized, appraise the results that are being attained against those that should be, pinpoint areas of weakness in any respect, provide the proper basis for determining whether equipment or practices should be changed, provide information permitting concrete help to the supervisor in doing his job, and provide a basis for determining standard cost.

BASIC STEPS—Steps in collecting the necessary basic data, or "elemental" or "raw" times, are basically the following:

Where to Find It . . .

Organizing for Control .... p 194
Adding the function . . . Providing personnel

Time Study ..... p 194
Elements and procedure

Determining Standard Times p 195
Converting recorded times . . . Fatigue allowances . . . Machine and man pacing

Methods Revision ..... p 196
Preliminary study . . . Standard data . . . Arriving at revisions

Operations Research ..... p 197

Incentive Systems ..... p 197
Basic considerations . . . Payment methods . . . Standard review

Cost Control ..... p 199
Production and delay reports

Budgeting ..... p 199
Budget goals and systems

A. Break the operation being studied down into the smallest practical elements that can be timed. The goal is to have a breakdown that will permit each element to be timed repeatedly without hesitation, and by anyone with a list of the elements. The first step therefore is to study the operation long enough to be able to break it down into elements that can be precisely described and timed. The description of the elements includes the "Start" and "Stop" points, arranged so that the stop point of one element is the start point of the next.

As an example, the process of unloading a shortwall cutter off a crawler truck might be oversimplified into two elements:

1. Tram.
2. Unload.

Actually, the breakdown that would provide a really useful working basis might be as follows:

1. Tram.
2. Unload tools.
3. Get in position to pull off rope.
4. Pull off rope.
5. Cut jack hole.
6. Set jack.
7. Tighten rope.
8. Position safety jack.
9. Unload.

B. Describe the elements so that they are recognizable by anyone familiar with the operation. In addition to this description, work up single-word summaries or symbols that can be quickly written by the man who actually does the studying.

An example of an element description in auger mining is as follows:

Head back:

Start: When drilling stops. Include uncoupling chuck from flights and tramming drilling head back.

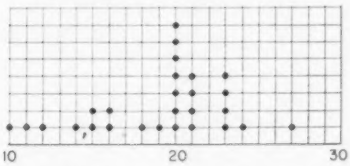
Stop: When head stops rearward motion.

C. Take the actual times, using a form on a clipboard and a stopwatch. A ruled sheet of paper may be employed or a form may be mimeographed or printed for the purpose. An accompanying example has columns for adjustment factors, discussed in the following section. The watch should be of the snap-back variety graduated in hundredths of minutes.

Determining Standard Times

TIME STUDY of a particular operation should be continued long enough to be sure that representative times are obtained. Some recorded times will show considerable variation. But whether the variation is little or great the question becomes one of determining the basic time.

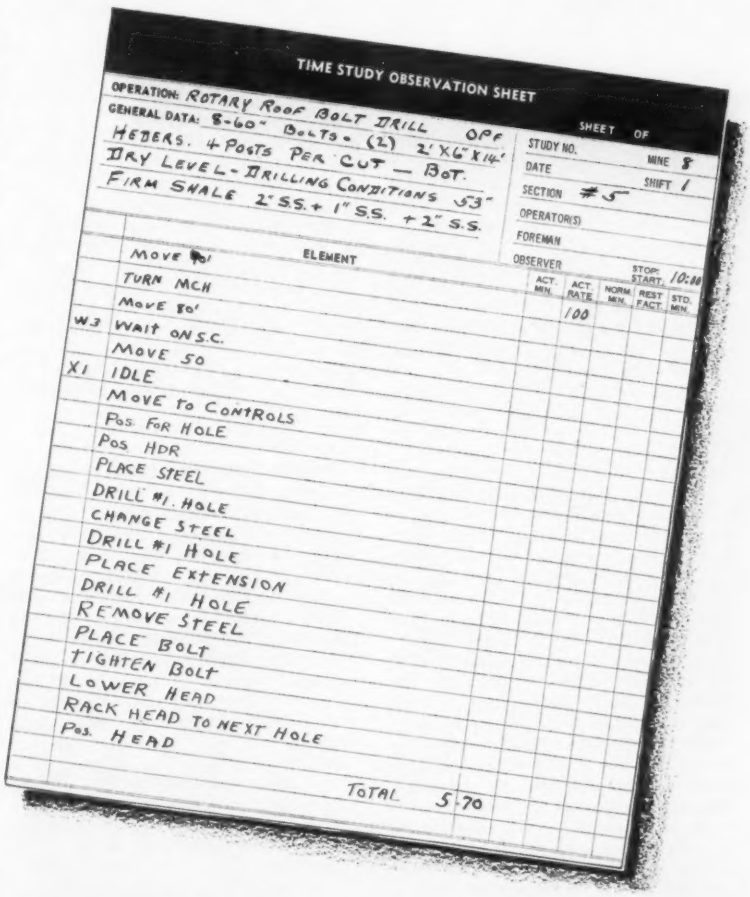
One method is to average the times. Another is to chart them by frequency, as in the accompanying illustration. In this example, the most-frequent time was 20100 sec. The arithmetical average would have been 19100 sec. The frequency chart, some industrial engineers contend, automatically eliminates abnormal times but at the same time keeps them available for inspection.



TIME CONVERSION—Having obtained the "average" or "typical" elemental or "observed" times, the next step is to convert them to "normal" times, and then include the proper adjustments for fatigue and the man's personal needs. The conversion of the "observed" time to "normal" is one of the areas in which accurate judgment is required. Normal pace is the working speed of a qualified operator at daywork tempo. (Many define this as the equivalent of walking at 3 mph on smooth, level ground without load.)

If, as an example, the observed time for a particular operation is 2 min and the time-study man concludes that the man is working at 10% faster than the normal pace, the observed time is increased to 2.2 min to obtain the "normal" time. This step is an essential one regardless of the particular goal. Otherwise, any attempt to revise methods, as an example, would fail because the times used were unrealistic, being either too great or not enough.

If the goal was also establishment of an incentive system, accurate determination of "normal" times is even more vital, since an incorrect normal will result, in one direction, in excessive earnings or, in the other,


TIME STUDY OBSERVATION SHEET

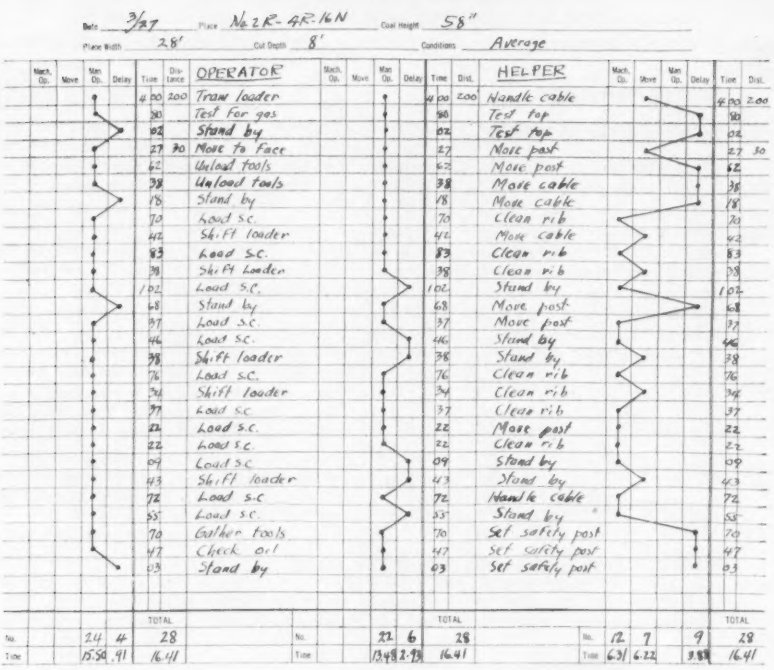
OPERATION: ROTARY ROOF BOLT DRILL OPR
GENERAL DATA: 8-60" BOLTS @ (2) 2" X 6" X 14' HEBERS. 4 POSTS PER CUT — BOT. DRY LEVEL - DRILLING CONDITIONS 53" FIRM SHALE 2" S.S. + 1" S.S. + 2" S.S.

SHEET OF
STUDY NO. MINE 8
DATE SHIFT 1
SECTION #5
OPERATOR(S)
FOREMAN
OBSERVER
STOP: START: 10:00

	ELEMENT	ACT. MIN.	ACT. RATE	NORM MIN.	REST FACT.	STD. MIN.
	MOVE 80'					
	TURN MCH		100			
	MOVE 80'					
W.3	WAIT ON S.C.					
	MOVE 50					
X1	IDLE					
	MOVE TO CONTROLS					
	POS. FOR HOLE					
	POS. HDR					
	PLACE STEEL					
	DRILL #1 HOLE					
	CHANGE STEEL					
	DRILL #1 HOLE					
	PLACE EXTENSION					
	DRILL #1 HOLE					
	REMOVE STEEL					
	PLACE BOLT					
	TIGHTEN BOLT					
	LOWER HEAD					
	RACK HEAD TO NEXT HOLE					
	POS. HEAD					
	TOTAL 5:70					

TIME STUDY OBSERVATION SHEET (shown here) contains space for noting all data necessary for a complete study of the elements of an operation.

Method Study Chart



BEFORE . . .

METHODS STUDY using special chart to permit showing relationship of operator, helper and machine at all times during the cycle. The aim is to pinpoint machine and man waits as the first step in reducing or eliminating them.

in little or no extra money, with consequent discouragement and failure.

FATIGUE ALLOWANCES—No man can work all-out for a full shift without rest. Consequently, fatigue must be allowed for by an adjustment of the "normal" times to convert them to "standard" times for performance measurement. The allowance varies with the job. A loader operator, for example, might be given an allowance of 10%, while the helper, with shoveling and other heavier tasks, might be allowed 25%. Next, the man must be accorded time for personal needs, for which an allowance of 5% usually is made. Thus, if the normal element time was 2.2 min, it would be increased by 15% in one instance and 30% in the other to achieve a "standard" time—matched to the pace the man could keep up.

Since many operations, such as loading out a cut of coal, include both manual, or "man-paced," and machine, or "machine-paced," elements, and men and machine are expected to finish together, it is necessary to increase any times recorded for the machine part of the cycle by the same allowances granted to the men. For example, a loading machine could complete a cut in 18 min of actual machine time cut after cut. The helper, shoveling loose coal and doing other work, could finish the first cut in 18 min with the machine but he would have no rest or other time out and manifestly could not keep the pace the entire shift. Thus, a standard set on the rate the machine could attain would be impossible for the man to maintain over the shift, so if machine time was used it would have to be increased so that the man could keep up and, if an incentive system was in operation, reach incentive rate.

Methods Revision

WHEN AN INDUSTRIAL engineering program is adopted the aim in the initial time studies is to start on a revision of methods—and possible equipment—to attain minimum cost. Once the revision is completed, time study can then be employed to see if the desired results are being achieved and further, to assess, if desired, the possibilities of new types of production facilities in place of those originally studied.

Time study therefore is the foundation for methods study. Balance is the goal, which in turn means eliminating waits, particularly of men on machines or on each other.

STANDARD DATA—Actually, although time study is the key in revising methods and checking on results it can be largely dispensed with after the initial shakedown period. The thing that makes this possible is "Standard Data," or compilations of standard times for various operations under varying conditions in the form of "Standard Data Tables" or "Standard Data Manuals."

If a new opening was planned, for example, using previously proven units, the data on standard operating times and production rates determined in the previous opening could be used to set times and production standards at the new. The saving in time-study expense is considerable. Many advocate maximum use of "Standard Data" for that reason. Of course, if a new condition is encountered or a new machine is involved, time-study procedure would have to be followed, unless data could be obtained from another user of the same machine under similar conditions.

METHODS STUDY PROCEDURE — The goal in a methods study is enough information so that the particular operation can be studied step by step, both men and machines together. Ideally, a film strip would be the best means of making such a study, with times being obtained by counting the frames consumed in covering a specific element. Several types of charts have been developed as substitutes for film strips. One is shown in the accompanying illustrations. It provides for parallel charting of the work of both men and machines.

The first step is to study the operation, in this instance loading out a cut of coal. The aim is to break it down into the proper elements and show the relationships of men and machine at all times during the cycle. When these have been plotted on the chart and the times have been added, the engineer or analyst is in position to initiate a methods revision.

ELIMINATING WAITING TIME — In the example illustrated it will be noted that there was considerable standby or waiting time in the original cycle, particularly on the part of the loader helper. How a revision might work out is shown in the second of the two charts. As a result of rearrangement of duties along obvious lines, the saving per cut is 3.72 min, meaning that output per shift should increase 18%.

It will also be noted that even after methods revision both operator and helper have some necessary standby time. The helper in particular is standing by a total of 2.3 min even after rebalancing. Can this standby time, and the standby time of the other men in a unit crew, be put to effective use? Frequently it can—by revising the

AFTER . . .

HOW OBVIOUS REBALANCING of the work load between operator and helper reduces total time for loading out a cut. The cycle still contains significant waiting time, which might be further reduced by study of other unit operations.

Method Study Chart

Date 3/27 Place No. 2 R - 4R-16N Coal Height 58"
Place Width 28' Cut Depth 8' Conditions Average

Mach. Op.	Move	Man Op.	Delay	Time	Distance	OPERATOR
				400	200	Tram loader
				80		Make gasket
				82		Check top
				27	30	Move loader future
				62		Unload tools
				38		Unload tools
				56		Stand by
				70		Load s.c.
				42		Shift loader
				83		Load s.c.
				38		Shift loader
				102		Load s.c.
				43		Wait for car change
				68		Stand by
				37		Load s.c.
				46		Load s.c.
				39		Shift loader
				76		Load s.c.
				34		Shift loader
				37		Load s.c.
				22		Move post
				53		Load s.c.
				43		Shift loader
				127		Load s.c. (clean up)
				72		Stand by
				70		Gather tools
				47		Check oil
				120		Stand by
			TOTAL			
	No.		23	5	28	
	Time		16.54	3.59	20.13	

Mach. Op.	Move	Man Op.	Delay	Time	Dist.	HELPER
				400	200	Handle cable
				80		Stand by
				82		Stand by
				27		Move safety post
				62		Move safety post
				38		Stand by
				56		Move cable
				70		Clean rib
				42		Move cable
				83		Clean rib
				38		Clean rib
				102		Stand by
				43		Stand by
				68		Move post
				37		Move post
				46		Stand by
				39		Stand by
				76		Clean rib
				34		Clean rib
				37		Clean rib
				22		Clean rib
				53		Stand by
				43		Stand by
				127		Stand by
				72		Handle cable
				70		Stand by
				47		Stand by
				120		Set safety post
			TOTAL			
	No.		16	12	28	
	Time		7.44	7.69	20.13	

Mach. Op.	Move	Man Op.	Delay	Time	Dist.
				400	200
				80	
				82	
				27	30
				62	
				38	
				56	
				70	
				42	
				83	
				38	
				102	
				43	
				68	
				37	
				46	
				39	
				76	
				34	
				37	
				22	
				53	
				43	
				127	
				72	
				70	
				47	
				120	
			TOTAL		
	No.	9	7	12	28
	Time	6.31	6.22	7.60	20.13

cycle with or without changes in equipment.

Analysis of methods in this or similar fashion is a major step to attainment of the most efficient system, but it is not the only one. In fact, complete success is not likely to be achieved unless the charts are supplemented by check lists of questions designed to force the analyst to consider all possible ways of improvement, including, for example, number of moves, accessibility to tools, placement of controls, character and training of the man in relation to the job (Is he the right one?), and so on.

Operations Research

THE METHODS REVISION aproaches outlined in the preceding section are a simplified form of an increasingly used technique called "Operations Research." It involves setting up a "mathematical model" of the particular operation being studied, developing the proper formulas and then calculating the results. For a fuller description of the theory and how it can be applied to mining operations, see the February, 1960, issue of *Coal Age*, pp 104-110.

COMPUTER SIMULATION—A major advantage of the operations-research approach is its adaptability to providing quickly and easily precise data on the results of changes in methods or equipment —say the number of shuttle cars serving a miner. Using data obtained by time study and other observations, the effect of raising the number of cars from, say, two to three, can be accurately predicted and a judgment made as to whether the step is worthwhile without the time and expense of an actual field trial.

Operations research has now been coupled with the electronic computer to permit analysis of complex systems up to entire haulage setups and the like, as well as all the possible variations in such systems, in a matter of hours rather than days or weeks. As a result, management now finds it practical to check completely into all possible variations before proceeding with a change in equipment or methods. The process is known as "computer simulation."

Starting with a miner unit, as an example, the computer can quickoy provide data on, say, the effect of the following: adding a man to the crew to cut the bolting cycle time, shortening the distance between transfer points to cut shutle-car disance, providing a feeder at the transfer point to permit sustained full-rate shuttle-car discharge, adding a pickup loader for faster shuttle-car loading, changing room and crosscut centers to cut machine travel time, and so on through all possible variations. It can provide the answers in terms of increased or decreased tonnage for each setup or the overall answer for all.

If purchase or rental of a computer is impractical, manufacturers of such equipment perform such jobs on a contract basis.

Incentive Systems

WITH TIME AND METHODS studies providing the most efficient production setup and an accurate measure of what performance should and could be, management then is in position to adopt an incentive-pay system or systems to further enhance the benefits. The incentive plan may be limited only to supervisors, which is the common practice in coal mining, or it may, as in some instances, take in both management and men.

Incentives for foremen differ from bonuses, such as Christmas and profit-sharing, in that they are paid on definite measured performance by each individual, and thus directly reflect effort and skill. They involve (*Coal Age*, January, 1958, p 104; October, 1958, p 86) the establishment of definite standards for performance, proper application of the standards, controls to make sure that safety and other factors are not shortcut, and employment of capable personnel to administer the plan.

Pitfalls to be avoided in setting up an incentive plan for foremen include:

Failure to sell the plan to all levels of management.

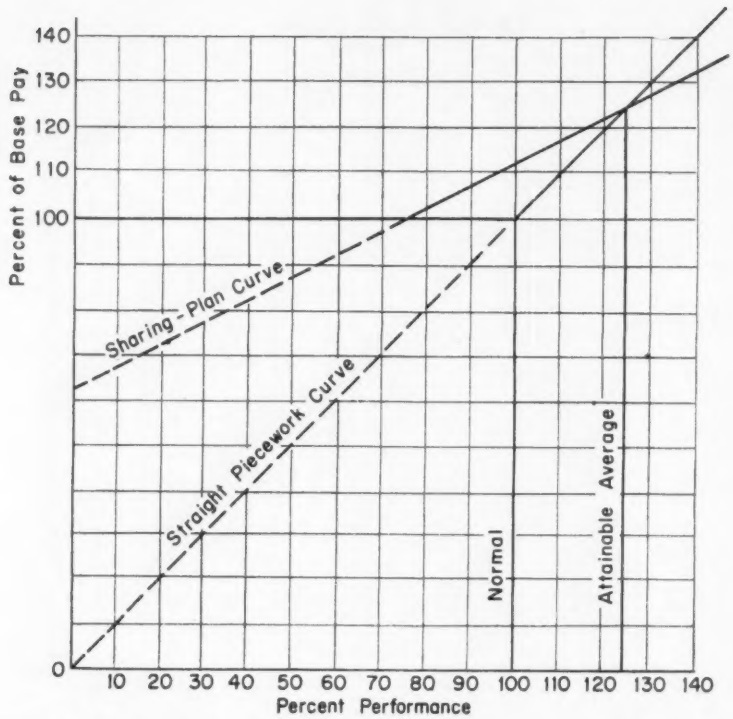
Use of the incentive plan as a "whip" for production, rather than as a tool for helping the foreman.

Partiality in the application of standards.

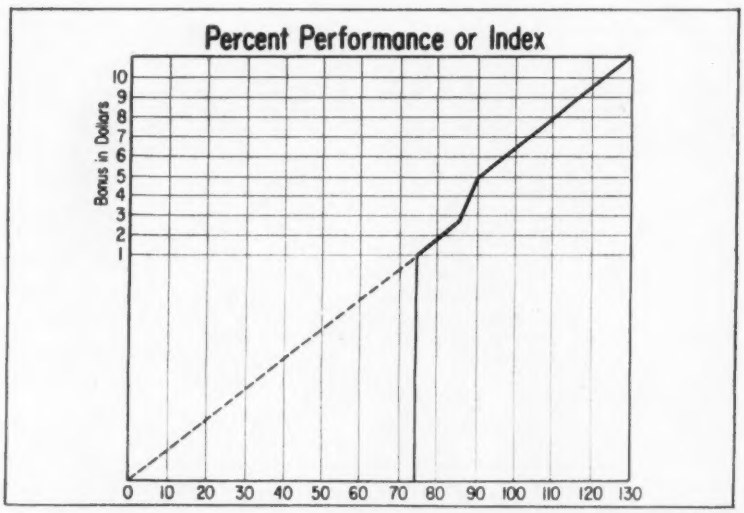
Use of adjustments unwarranted by conditions.

Failure to change the standard when methods, crews, equipment or practices change. For example, if an incentive plan is to be fair to foremen and company (and to men if they are included), each section should be regularly reviewed, perhaps each week, and the bogey for the foreman and crew set in accordance with the section rating—normal, good, fair or poor, for example.

A wage incentive plan also can be used to pay workers extra money for performance above normal—in other words, for doing assigned work in less than normal time. If a wage incentive plan is adopted, an essential desision is the performance-pay relationship, or curve.



HOW INCENTIVE PAYMENT PLANS compare at various stages of performance. The sharing plan is suggested where it is difficult to establish precise standards because of unavoidable severe fluctuations in performance. Plan shown in chart below provides for the extra effort necessary at one point.



INCENTIVE-PAYMENT PLANS — A common method of payment is the hour-for-hour straight-piece-work curve, or 1% extra pay for each performance percentage point above normal, or daywork, performance. As a rule it is expected that the workers can attain an average performance of approximately 30% better than normal.

Conditions can fluctuate widely in certain occupations, including coal mining. Such fluctuations are beyond the control of the workers and, to some extent, management. Frequently, development and application of accurate time standards that reflect these variable conditions are economically impractical. A popular method of applying incentives under these conditions is to slant the performance-pay curve away from the "one-for-one" ratio toward the horizontal. The effect of such a "sharing-plan" curve in comparison with the straight piecework curve, is to pay some bonus for less than normal performance, a higher percentage of bonus for performances under the expected average incentive performance, and a lesser percentage of extra pay for performances above the expected average (see chart).

The advantage of the sharing plan is reduction of wild fluctuations in pay in comparison with, or in relation to, the unavoidable fluctuations in performance. Over a period of time the averages of pay-performance relationships should be approximately the same with both curves.

Variations of either curve are possible, and are used. One in actual use for foremen (see chart) is based on paying at 74% of section potential, arrived at by dividing this potential, determined from previous time-study and standard-data compilation, by actual performance in tons and multiplying by 100. At one point where extra or outstanding effort is required earnings are at a higher rate, after which the curve reverts to a straight line.

The bonus to be paid at attainable, or expected average, performance is a policy decision. Generally, it is somewhere between 20 and 35%, but can be set between 10 and 50%. Naturally, if the pay-performance ratio is other than 1% for 1% (0% at normal, 25 at 25% above normal), there must be a formula to convert performance to incentive pay.

Payment of 1% extra pay for each 1% extra performance (the "one-for-one" plan) results in a fixed direct labor cost per unit of output for any performance above normal. However, such a plan offers two sources of cost reduction: attaining and maintaining performance above normal; and reduction of overhead costs in relation to direct labor costs.

Under the incentive system the man or men earn extra pay by doing a certain job in a certain time as, for example, completing a cut in 28 min instead of 33, or by achieving more than the standard, or base, production level in terms of tons per shift, per week or per month. In both instances, the emphasis is on a carefully determined standard, rather than on exceeding previous production figures, since even the higher figures might be well under what the use of industrial-engineering techniques would show should be achieved.

STANDARDS REVIEW—In coal mining major variations in conditions can occur, greatly influencing the results that are possible to achieve. Keeping pace with these changes and thus keeping the standard times used for rating performance and paying incentives realistic therefore requires that each new working section be rated and standard times set accordingly. If enough time studies are made under varying conditions, making actual time studies in new sections becomes unnecessary. Rather, the section is inspected and rated, and appropriate times or output derived from previous work ("standard data") are prescribed.

Of course, if a new machine is installed or if the system of operation is changed in any signicant respect, sufficient new time studies should be made to develop realistic new standards.

The accompanying illustrations show two forms of rating reports which also provides an opportunity to remedy conditions that might otherwise cause undue delays, prevent the crews from reaching standard and, in consequence, up the cost.

REVIEW AND RATING PROCEDURES for the establishment of specific performance standards take the guesswork out of control and insure fairness of incentives, if paid. They also can be employed to reveal bottlenecks and handicaps on performance.

Cost Control

AFTER STANDARDS AND METHODS have been determined, the next step is proper provisions for control. Production and delay reports are basic, and should be supplemented by budgeting and other steps for the lowest cost.

PRODUCTION AND DELAY REPORTS—An example of how production and delay reports might be set up is shown in the accompanying illustration. In this instance columns on changing distance and standard shuttle-car wait are included for more precise control over this important phase of the face operation.

On this particular shift, if incentives were being paid on the basis of standard times, the crew would have performed 280 standard minutes of work in 245 clock min, the latter representing 480 min minus 38 min for travel and other delay time, including the shuttle-car wait. Thus, they would have earned, on the straightline basis, at a rate of 114% (280 ÷ 245). In short, the men were trying and the fact that only 13 cuts were completed, rather than 20 or more was more the fault of supervision and of management policies. These included failure to anticipate the occurrence of certain troubles, such as getting the loader stuck, and, as another example, the tolerance of cable conditions almost certain to result in delays. Had the crew in contrast, loaded out only 11 places, it would have taken more clock time than standard time to complete the cuts, and thus the men would not have qualified for bonus pay.

This particular production and delay report shows the cost of delays in terms of dollars of expense, including fixed charges. The total assumed for this example is $1 per minute. The figure used at any particular operation would depend on the setup at that operation. In any event, showing the cost in dollars helps concentrate attention on the items that result in the greatest losses and at the same time are susceptible to correction, eliminating, of course, delays which are unavoidable, such as, travel, inspection, lubrication, etc.—though only to the extent of the standard allowed. This standard, in the case of lubrication, might be 6 min instead of the 8 shown.

The standard times, money, cost of delays and other similar data, with forms of this type, are filled in in the office, leaving to the foreman the task of recording maximum and minimum shuttle-car haul, cuts loaded out, shuttle-car change distance, and delays and delay times.

Budgeting

THE BUDGET represents the ultimate step in achievement of effective cost control. It provides an opportunity for showing, in tons of output and dollars and cents, what

WEEKLY SECTION REPORT

MINE NO. _____ SECTION _____ SHIFT _____

Standard Crew _____ Men Week Ending _____

GENERAL CONDITIONS:

Describe any non-standard conditions: _____

Headings	Width	Rock	Bone	Coal	Total Height

FACE CYCLES: Cutting and Drilling:

Standard Face Width			
Type Machine			
Length Bar			
Bottom Class		Cutting Time	
Cutting Class			
Coal Drill Class		Drilling Time	
Coal Face Class		Cutting & Drilling Cycle	

Shooting:

Face width			
Bug Duster Class			
No. Coal Holes			
No. Rock Holes		Shooting Cycle	

Loading:

Volume Matl. cut			
Bottom Class			
Top Class			
Loader			
Loading Class		Loading Cycle	

Haulage:

Avg. Haulage Dist.			
Top Class			
Bottom Class			
Cars (type)		Haulage Cycle	

Top Support:

Top Class			
Bolt Length			
Average Height			
Type Top (Drilling)		Top Support Cycle	

FOREMAN ENGINEER

REPORT OF
SECTION EXAMINATION AND CLASSIFICATION

MINE NO..... DATE..... I.E.REPR.....

SECTION LOCATION	SECTION FOREMAN	NO. OF MEN

PLACE	CLASSIFICATIONS		

AVERAGE CLASSIFICATION:

STD.TONS/SHIFT	STD.TONS/MAN	NO. CARS/SHIFT

COMMENTS

TRACK OR ROADWAY	SHOOTING
CUTTING	LOADING
DRILLING	CAR OR BUGGY CH'GE
DUSTING	TRIP CH'GE
POWER GOOD ☐ BAD ☐ INT. ☐	SUPPLIES

COMMENTS AND SUGGESTIONS

DAILY LOADER REPORT

Date 4/28 Shift 2 Section 4R 16N

Loader No. 3R Shuttle Cars Used 2

Shuttle-Car Haul: Maximum 510 Minimum 285

Tons per Room Cut 25 X Cut 22 Hdg. Cut 18

Place No.	Std. Cut Time	Shuttle-Car Change	Std. Car Wait	Delays	Min.	Cost $
R2	24.0	60	1.3	Loader stuck - soft bottom	38	38
R3	24.0	60	1.3			
X3	19.0	60	1.3	Splice loader cable	12	12
R4	24.0	80	1.9	Splice loader cable	13	13
R5	24.0	80	1.9	Hung cut	18	18
R6	24.0	60	1.3	Car off - ramp	22	22
X6	19.0	60	1.3	Power off	9	9
R7	24.0	60	1.3	Clean fall R4	14	14
X7	19.0	60	1.3	Splice conv. chain	16	16
H1	18.0	70	1.6			
XH1	19.0	70	1.6			
H2	18.0	70	1.6			
R1	24.0	110	2.5	Std. Delay Allowances:		
				Travel	38	38
				Inspection	12	12
				Lubrication	8	8
				Shuttle-Car Wait	20	20
				Normal Unavoidable	15	15
				Total	235	235
				Std. Delay Allowances	93	93
TOTAL	280.0		20.2	Loss	142	142

No. Room Cuts	7	X Cuts 4	Hdg. Cuts 2	Total
Tons per Cut	25	22	18	
Total Tons	175	88	36	299

PRODUCTON AND DELAY REPORT shown here is based on the use of standard times and shows the money cost of delays. Comparison of performance with engineered standards insures accuracy in cost control.

should be obtained after proper standards are set up, and at the same time provides an opportunity for comparing actual results with the budget goal. This makes it possible to pick up losses immediately—as frequently as every day, in fact.

Standard costs, category by category—with as many categories as feasible—are the key item in an effective cost-control budget. Among other things, this type of budget shows realistically what the mine cost should be, pinpoints categories where expenses are out of line and requires an investigation and explanation, permits delegation of cost-cutting responsibility, and functions as a tool in evaluating practice and equipment and projecting desirable changes.

Budget systems and forms naturally will vary but the principles and functions are basically identical. Assume that a mine is operating four sections two shifts a day. Two of the sections are rated at 350 tons per shift, one at 380 and one at 300. The standard crew for three is 14, and for the fourth, 12 men. This rating is based on a reasonable minimum of delays and of course on the expectation that the units will perform at the pace determined as a result of time study and methods revision.

Management has orders or the expectation of orders sufficient for a four-day schedule for the week in question. With this as the goal, the budget is worked up to provide for the normal labor, materials, power and other costs, and for certain especial work to the extent that costs for the week are not seriously distorted. The budget then is set up along these lines. In this instance, it is assumed that no incentives are being paid. If they were being paid to foremen, or foremen and men, the wage totals would reflect the extra payments expected from attainment of incentive pace.

Output, tons	11,040	Per Ton
Section labor, 512 shifts	$11,776	$1,067
Section supplies	1,435	0.130
Roof support, 72 shifts	1,584	0.143
Timber, bolts, other	2,043	0.185
Main haulage, dumping, 40 shifts	880	0.080
Haulage supplies	103	0.009
Track, 10 shifts	220	0.020
Track materials	350	0.032
Pumping and drainage, 8 shifts	175	0.016
Drainage supplies	60	0.005
Ventilation, 10 shifts	220	0.020
Ventilation supplies	277	0.025
Supply handling, delivery, 20 shifts	440	0.040
Preparation, 64 shifts	1,344	0.122
Preparation supplies	760	0.069
Maintenance shop, 60 shifts	1,380	0.125
Parts and supplies	2,260	0.205
General inside, outside, 10 shifts	215	0.019
Supplies	42	0.004
Idle-day labor, 8 shifts	164	0.015
Supplies	48	0.005
Power	1,480	0.134
Power supply, 10 shifts	230	0.021
Power supplies	130	0.012
Office staff	380	0.034
Office supplies	32	0.003
Telephone, telegraph	103	0.009
Mine supervision	1,930	0.175
Outside supervision	700	0.063
Safety & inspection	320	0.029
Safety supplies	65	0.006
General & administrative	400	0.036
Special Jobs		
Complete mainline extension:		
Labor, 22 shifts	484	0.044
Materials	2,840	0.257
Start overcast, 4R 16S:		
Labor, 6 shifts	190	0.017
Materials	45	0.004
Start clearing site for new portal:		
Labor, 15 shifts	330	0.030
Materials	160	0.014
	$35,595	$3.224

The preceding is not, of course, in the sheet form an actual budget would take, nor is it presented as a typical breakdown of items. Rather it is intended only to illustrate the basic approach.

For the maximum degree of control, the weekly (or monthly) budget should be broken down into daily budgets, by section and department or activity, such as haulage or maintenance. These budgets, plus matching weekly or monthly budgets, are then given to the supervisors directly responsible as guides and standards for them. With these budgets, and with supplementary production and loss reports, such as those discussed earlier in this section, the stage is set for precise control, since the superintendent or other manager can see each day where the standards are being exceeded and, through the loss reports, the reason why. Thus remedial action can be immediate.

Budgeting can be quite precise, in spite of the variables inherent in mining. A number of companies report that they can come within 3 to 5% of actual cost in budgeting, which means that the budget is a reliable tool—the final weapon in the arsenal.

The Deep Mining Guidebook . . .

Low-Cost Development For Sustained Efficiency

Basic Points

1. Minimum investment in openings and plant facilities.
2. A basic layout providing for changes and expansion to take advantage of new developments in equipment and methods.
3. A mining system tailored to meet conditions and get the most out of the equipment selected.
4. An entry-driving and development system taking full advantage of modern methods, and providing for mining with a minimum of trouble and a maximum of efficiency.

Field Follow-Through

1. Locate portals for lowest mining cost throughout mine life, not forgetting the possibilities of water transportation, the desirability of moves or the need for auxiliary portals at certain development stages.
2. Mechanize shaft and slope sinking and rock tunneling, including outlining by drilling; also use gels, concrete additives and other auxiliary measures for solidifying strata, sealing off water inflow, etc.
3. Project for full retreat, if possible; if not, for as much retreat as possible; provide bleeders and escapeways, and give careful thought to pillar sizes and methods of removal.
4. Provide, in entry-driving, enough area for air and enough openings for other services; also adjust number of openings to give equipment employed the best possible opportunity. And, of course, mechanize entry advancement and any rock removal and disposal.

Practice Trends

Basic developments approach more and more to (1) big operations with up to 50 yr or more of life and (2) contour or punch operations in hilly or mountainous country for simplicity in development and higher efficiency. Contracting in punch or contour work is an increasing practice.

Slopes still firmly in favor as main hoisting openings. In addition to ventilation types, there is increased activity in sinking shafts back from main openings to improve ventilation, cut man travel and make maintenance and supply activities more efficient. A substantial percentage of such shafts are being drilled.

Retreat operation becoming more nearly universal, either full from the property limit or within sections when coal is worked on one side of the mains on the advance and on the other side on the retreat—a growing practice.

Locating the Portal

Locate, as a general rule, for lowest mining cost over life of property consistent with convenience for men and handling of coal and materials.

Consider the needs for raw- and prepared-coal storage.

Consider the possibilities of locating to facilitate present or future water connections, either directly by a plant on water or by truck, rail or overland belt from mine to barge-loading plant.

COST FACTORS—Among the reasons for care in planning initial and future openings or plant locations are:

1. Increasing cost of opening and equipping, ranging up to $8 to $10 per ton of annual capacity, including preparation plant and other service facilities, as well as coal and surface rights, and averaging $3 to $6.
2. The increasing penalties incurred for extra haulage, air travel and man travel. Now, unproductive time is paid for at better than $3 per hour. For an extra half hour of travel, with 100 men employed underground, the cost is over $150 per day, for which no coal is received.

DATA REQUIREMENTS — These include:

1. **Depth of cover.**
2. **Dip of coal.**
3. **Major faults or wants.** Drilling, surface and outcrop surveys and level determinations are major methods of obtaining these types of information. Depth of overburden determines the economical number of holes. In average hilly country one hole up to 500 to 600 ft deep every 5 or so acres is fairly common practice, with more holes as depth decreases. Where there is no outcrop access and the coal is over 1,000 ft down, only an occasional hole is possible, but even this occasional hole can provide some assurance that there are no major wants or faults, and in addition provide elevations and cores.
4. **Topography.** Contours should be shown in 5- to 10-ft intervals, if possible, and the map should include enough of the surrounding area to permit good planning of railroad and road spurs, power lines, etc. It also should provide ready information on available land for auxiliary portals, coal storage, refuse dumps, fresh and dirty-water storage ponds, and so on. If the property is of some size, the production of such a map or maps usually can be accomplished by aerial surveying at a saving of one-half to one-third normal ground-survey costs.
5. **Water sources.** If surface runoff is insufficient, will wells be needed or dams for storage?
6. **Reasonably accurate costs** for such items as railroad and road-building, high-line construction, filling, foundation construction, etc., for varying conditions to permit the proper choice between alternative layout plans.

WATERSIDE LOCATION — If major markets can be reached by water, substantial savings in freight are possible, with resulting improvement in competitive position.

But if the location is back from the waterway how long a rail or truck haul is feasible? On the basis of examples to date, rail hauls of 10 mi for outputs of 1 to 2 million a year or more are apparently quite bearable. At 2 million or more, the thinking is for a maximum of about 25 mi where construction would not be too difficult. For trucks, a rough rule is half the rail distance, though a highway haul may have other limitations growing out of local or state regulations.

PLACING MAIN OPENING — Other things being equal, the main opening should be placed in the center of the property for

Where to Find It . . .

Portal Location ..... p 201
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Mechanical Shaft Mucking—Overshot loader used in 37x14-ft air shaft. With 11-man crew sinking rate is 6 ft per shift. *Coal Age*, July, 1956, p 72.

Slope Sinking With Rock Loader and Extensible Belt — How this combination of equipment is used to attain rates of 4 to 10 ft per shift in 9x18-ft opening with four-man crew. *Coal Age*, November, 1956, p 68.

Drilling to Outline Shafts, Water Sealing, Simplified Lining—New drilling techniques increase depth at which outline drilling is possible. Drilling also used to facilitate grouting of both unconsolidated surface material and rock layers at low pressure with the aid of chemical additives. Special demountable form and use of boreholes speeds lining. *Coal Age*, June, 1958, p 106.

Safety in Mine Design and Development—How roof control, mining plans, power source and main haulage were set up for maximum safety. Entry driving and other development, using ripper-type miners, adjusted to provide alternate shuttle-car roads to belts. Slopes were driven mechanically and shafts were outlined by drilling. *Coal Age*, September, 1958, p 92.

High-Tonnage Punch Mining—Basic considerations and actual plans for developing small "punch" mines approximately 5,000 ft along the outcrop and 7,000 ft deep. Mining is by loader, shuttle car and belt to main line. *Coal Age*, January, 1959, p 104.

Rippers and Loaders—Two ripper-type miners advance five center headings of an 11-heading entry. Outside headings are driven by loader-bridge conveyor equipment, also found useful any place soft bottom is encountered. Miner units in 5-ft coal average 560 tons per shift. *Coal Age*, March, 1960, p 70.

Borers and Loaders—Five-heading entries are driven by both loader-shuttle car units and twin-head borers, also served by shuttle cars. Mine cars receive coal on loop tracks. *Coal Age*, May, 1960, p 70.

lowest cost over its life. But if grades are pronounced (over 1½ to 2%, say), again with other things equal, the opening should be placed to favor loaded haulage and gravity water flow.

MOVING MAIN OPENING—Normally, the main preparation plant would be expected to last at least 20 yr, and usually the main opening would be expected to remain at that same location. But there are circumstances where, even though the preparation plant stayed put, the main opening should be moved. If tonnage was high, for example, the haulage distance increased rapidly, assuming mining on the advance, and conditions favored an economical overland haul, the main opening might be moved at the end of, say, 10 yr.

In at least one instance, the coal area was divided into quarters and the initial slope was sunk in the center of one quadrant. When it is exhausted, coal from the second and succeeding quadrants may be brought in underground or by means of a surface haul, depending on thinking at the time.

MULTIPLE OPENINGS—The conditions that might favor multiple openings include a hilltop where an outside haul road could be constructed fairly easily, or where the outcrop had been stripped. In addition to the obvious advantages of a lower cost haul—usually the situation with transportation on the surface—mining, ventilation and other operations, including travel, would be materially simplified.

A design for a large tonnage might be based on two or more openings, though only one preparation plant, because of the complications of trying to, say, hoist a high output out of one shaft or slope.

Multiple openings are of course inherent in punch or contour mining—a growing practice in recent years for efficient extraction of coal in hilltops. At such operations, new openings may be made at distances as short as 500 ft. But even though there is no such thing as a main opening or openings, location of the preparation plant, shop and the like can have a significant bearing on overall cost.

SEPARATING PORTAL AND PLANT—Putting the portal and the preparation plant at different places may be the better answer to the dual problems of locating the opening at the best point for low mining costs, and the plant at a place where ample space is available for good design, ample coal storage, good water supply, access to a waterway, and so on.

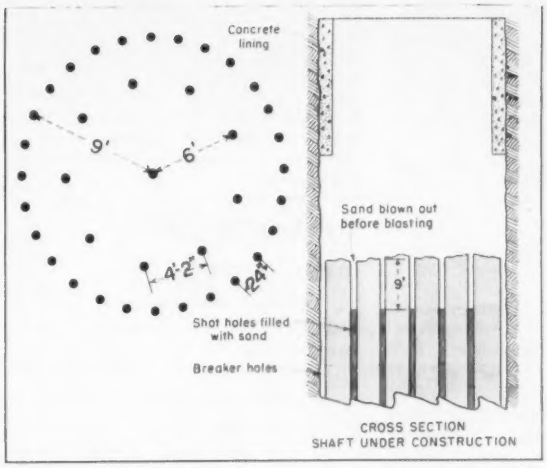
Location of the preparation plant completely away from the mine for the same reasons is a further possibility.

SPACE REQUIREMENTS—Space for both present and future facilities should be provided for in the original planning for the portal or portals. The needs include:

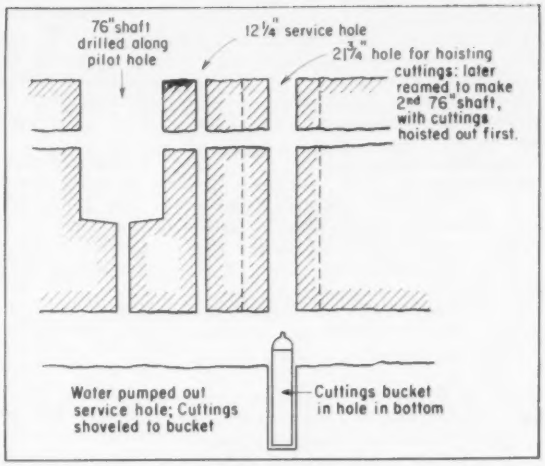
1. Parking for as many cars as may be necessary, preferably on level or nearly level ground for easy movement at times of snow.
2. Coal storage. If not provided when the plant is built it may be necessary at a later date. Storage facilities for as much as a week's run or more of raw or prepared coal, or both, are not uncommon nowadays. Even where capacities are more modest, the trend is toward providing bin or ground storage for up to a half day's supply.

AUXILIARY PORTALS—Aside from providing a means of getting out the coal, openings into the mine provide travelways for air, men and supplies. The farther the openings are from the face the more expensive all of these—travel time in particular—become. It could pay, if deep shafts were not required, to make new openings for air about every mile; for travel and supply handling, every 2 mi or so.

Drilling shafts for air and supply handling—and even for handling men—is a handy and economical method where outcrop access is not possible. Cost is relatively low, and if the diameter is 4 to 5 ft or more they can be equipped with cages fairly easily and inexpensively.



OUTLINING BY DRILLING cuts cost of sinking shallow shafts by up to 50% with new grouting, mucking and lining techniques.



PILOT HOLES facilitate big-drill sinking of a pair of man and service shafts. Center hole serves for power and water.

Sinking Rock Slopes

Muck with loading machines and transport on conveyors in slopes designed for belt hoisting.

Consider the possibilities of continuous miners to eliminate drilling and blasting where there is not a great deal of very hard material, such as, sandstone and limestone.

EQUIPMENT AND FACILITIES — Shovel, dragline or bulldozer for preliminary excavation if the material is fairly deep and soft. A bulldozer normally is required in any event for miscellaneous earth moving and excavation, and for spreading refuse. These and certain other units frequently can be rented, rather than purchased.

Storage bin on surface unless muck is dumped directly to trucks. Normally, a bin will pay off by preventing delays and interruptions.

Refuse-disposal and service trucks.

Electrical substation or engine-generator plant.

Field shop.

Field supply house.

Field office, locker and change facilities. These, as well as the field shop and supply house, may all be in the same structure or separate buildings may be employed, including semiportable or prefabricated. Though it is not usual practice, the permanent buildings to serve the mine throughout its life may be erected in advance of portal development.

Fan or tubing blower, with duct or tubing.

Water supply for wet drilling, sprinkling and general use.

Pumping equipment, if necessary, for dewatering slope.

Concrete-mixing facilities, unless ready-mix is available at a desirable price. As an alternate to at least part of the concrete work, steel liner plate may be employed. Concreting or lining normally is done only for the softer section of material at the top of the slope. Below that, the natural-rock ribs normally will stand and the top can be taken care of by bolting or conventional timbering. Bolting also may be employed to keep ribs from sloughing or caving. Spraying with a sand-cement mixture on wire mesh also may be done to prevent spalling and disintegration as a result of temperature and moisture changes, or ribs may be coated with roof-sealing compounds.

Gel or other facilities for sealing off water, if encountered, unless other means are employed.

SUPPLY-TRACK POSITION—The usual belt slope also is employed for handling men and supplies. Consequently, the belt normally is placed to one side with the track at the other and the stairs in the center. However, all other arrangements have been employed, including increasing the height of the slope and putting the belt on crossbeams over the top of the supply track and stairs. In one instance, this double-decking was done to cut slope width in poor ground.

The belt or supply track may be separated from the other facilities in the slope by guard rails, low concrete curbs or walls, a center line of roof supports, or industrial fencing. For easy walking, one mine built experimental steps and had men try them. As a result, the stairs were built with a 6-in rise and a 24-in tread.

Because of the length of time required in sinking the longer slopes, and also because of the long tubing runs that would be required, it may become desirable to erect a center partition, thus establishing two compartments for ventilation. Rather than use shiplap or standard brattice lumber, thin-section plywood in standard-sized sheets offers economies in both purchase cost and cost of installation. Plastic sheeting is another possibility.

Methods of handling heavy inflows of water from soft water-bearing measures including standard grouting and also use of gel-type chemicals which solidify after pressure injection and render the material impervious.

Sinking Systems

Depending upon the mucking system adopted, equipment normally employed in slope sinking is as follows:

HAND MUCKING

Hoist on surface (50 to 75 hp, single drum, in most instances; same hoist may be continued in service to handle supply cars in regular operation).

Muck car.

Air compressor.

Drilling equipment. Hand-held or other unmounted drills may be used, but their footage is lower. At the other extreme, a track-mounted jumbo — one or two drill mounts—may be employed for maximum drilling speed in slopes up to 45 to 50 deg even though it may be necessary to pull it out between rounds or provide special parking facilities near the face. Between are column- or bar-mounted drifters or sinkers, as well as newer air-leg or jack-leg units.

Roof-bolting equipment rounds out the list, unless conventional supports are employed.

CREWS AND PERFORMANCE—Minimum crew for such a sinking job probably would be approximately as follows, these men also taking care of installation of lining and roof support: drilling shift—two or three drillers, mechanic or electrician, and a handyman (hoisting, supplies, etc.); mucking shift—two or three muckers, hoistman, truck driver and dozer operator.

It sometimes is possible for one man to take care of all hoisting and refuse disposal, although normally more than one are necessary, in which event the truck driver, dozer operator and any others employed normally will handle miscellaneous duties. And, as noted, all men will be available for installing lining, supports and the like. On this basis, average advance in a 7x15-ft slope would be 3 to 4 ft per shift—perhaps more with favorable conditions or jumbo or other high-speed drilling.

MACHINE MUCKING

Where muck is loaded mechanically, the equipment setup may be as follows:

Hoist.

Muck car or conveyor system. The latter may be chain equipment only, or a chain unit may be used between a belt unit, which

eventually will become the slope conveyor, and the face. The latest addition to the group is the extensible belt. Its use is outlined later in this section.

Standard coal-loading machine, or rock loader of the standard, overshot or slusher type.

Air compressor.

Drilling equipment — substantially the same as with hand mucking. However, where crawler loaders are used and consequently cannot be hoisted out readily it may be difficult to use jumbos because of interference.

Roof-bolting equipment (unless conventional support is employed).

PITCH FACILITIES—Standard or conventional loading machines usually are limited to 20 deg or less, though the overshot unit of the track-mounted type can operate on somewhat heavier inclines. With certain types of slushers, mucking can be done at up to 50 deg, other conditions being favorable.

The "helldiver," though employed mostly in coal (see "Sinking Coal Slopes"), also may be adapted to sinking in rock at pitches up to 50 to 60 deg.

Where conveyors are employed to move muck the practical limits are about as follows: belt 17 to 20 deg; standard chain, 30 to 35 deg; special high-flight chain conveyor designed for hoisting work, 45 to 50 deg. Where the slope is long, chains must be used in tandem, since the practical working length usually is not over 300 ft, particularly if operated up hill.

With slightly different duties, crews for machine mucking can be about the same in number as with hand mucking. Rate of sinking in a 7x15-ft slope, including lining and support, usually ranges from 5 to 10 ft per shift.

MUCKING WITH EXTENSIBLE BELT—Latest addition to the list of slope-sinking tools is the extensible belt. In combination with a rock loader at one property (*Coal Age*, November, 1956, p 68), its use resulted in sinking rates of 4 to 10 ft per shift in a 9x18-ft opening (before lining) on an inclination of 15 deg. The 36-in extensible unit was equipped with a special 100-ft takeup to permit tramming a safe distance back from the face before shooting. It discharged to a truck-loading bin on the surface.

The sequence of operations included drilling with telescopic leg stopers, concentrating first on bolt holes for roof support and then changing to the face. Next the holes were loaded and shot. Bolting, face drilling, loading, moving equipment back, etc., including shooting, took a four-man crew about 2½ hr. Loading was the next operation, with one man operating the loader, a second running the self-propelled tail piece of the extensible conveyor, a third acting as handyman at the face and the fourth working on the surface trucking away the rock.

Finished dimensions of the slope were 7x16 ft, achieved with a 1-ft concrete lining in part and a sand-cement coating on wire mesh on the remainder. The initial opening on the surface was made with a shovel and bulldozer, followed by installation of the concrete lining down to the solid.

CONTINUOUS SINKING

In addition to growing effectiveness in coal, continuous miners also are proving quite effective in slope sinking and other rock work where conditions are not too difficult. Equipment usually employed is as follows:

Sinking machine. To date, these have been of the boring type and have been used only in sinking belt slopes on inclinations of around 20 deg or less.

Conveyor system (muck car an alternate).

Roof-bolting equipment (unless conventional support is employed).

The use of continuous-type mining-and-loading machines for slope sinking is a relatively new development. Results so far indicate that advances of 10 to 30 ft per shift are possible, depending upon the hardness of the rock. Since hard sandstone, limestone and the like still are tough for mining-and-loading machines, they normally should be considered only where shales and other soft material predominate.

Sinking Coal Slopes

Use loading machines or continuous miners where pitch permits; where pitches are beyond those on which loaders or miners can operate, consider special units, such as, the "helldiver."

Where pitch permits, use conveyors for transportation. Special high-flight chain conveyors can operate at up to 45 to 50 deg.

EXCEPT THAT THE PRODUCT normally is not dumped to refuse, sinking slopes in coal is substantially similar in practice to sinking in rock. Equipment normally is of the coal type, and aside from loaders and the like, may include coal cutters, unless pitch, interference or other conditions prevent. With some exceptions electric coal augers are standard for drilling, and the cycle corresponds with the cycle in a room face.

Cars or skips may be loaded by hand up to 75 to 80 deg. Conveyors may be loaded by hand up the limit of 45 to 50 deg for the special high-flight hoisting type. With loading machines, the usual limit for conveyors is around 20 deg. The maximum nose-down pitch for continuous miners still is to be determined, but they are promising candidates up to 15 to 20 deg.

SPECIAL MUCKERS — The "helldiver" is one of the special machines for fast loading in slopes up to 50 deg. It consists of a scoop on the front end of a weighted truck (*Coal Age*, May, 1951, p 100). With the scoop down, the helldiver is dropped into the loose coal at the face. In hoisting, the scoop is raised automatically and the entire unit is pulled to the dumping point —normally a hopper under the track with an opening between the rails. The hopper is above the haulage level and false rails permit hoisting over the level track. Coal is transferred from the hopper to cars on the level road by an elevating conveyor.

In 4½-ft coal, places 10 ft wide, with crews of 3 to 4 men, average production with the helldiver is one 7-ft-deep cut per shift, including installation of permanent roof supports and other necessary operations. With loading machines in slopes under 17 or 18 deg, 5-ft coal or thicker, the usual advance is 1 to 3 cuts per shift, with the higher figures possible as a rule only where there is little need for installing permanent supports. Advance with hand loading, whether into cars or conveyors, seldom is over one cut per shift with a 3- or 4-man crew.

Raising Slopes and Airways

Consider continuous miners for moderate pitches, and conveyor transportation up to sheet-iron pitch.

Consider big drills for parallel airways in steeper pitches.

MACHINE LOADING is as desirable in raising slopes and airways in either coal or rock up to say, 20 deg, as in sinking or production on the level. Although equipment can be installed to take cars to the face, the preferable transportation medium is the conveyor up the point where the material will run on sheet iron, which is around 30 deg. At around 35 to 40 deg, coal will begin to run on the bottom rock, and above approximately 45 deg, checks or batteries are required.

RAISING WITH CONTINUOUS MINERS—Where raising is done in coal, continuous miners have been successfully used on pitches up to 15 deg or better. In one instance, using pickup loaders, shuttle cars and cross-measure shakers for gathering, six airways were driven 1,500 ft up pitch to the outcrop by ripper-type continuous units with a substantial saving in cost over other methods. Maximum pitch encountered was 12½ deg.

In addition to raising parallel airways with conventional equipment operated from crosscuts off the main slope big drills also have been used. At one mine (*Coal Age*, May, 1951, p 100) such a drilling unit is fitted with a 42-in head; and one, two or three holes are drilled up the pitch to achieve the desired airway area. Drilling is done from crosscuts at the necessary intervals.

Shaft Sinking

Mechanize with tractor loaders for handling muck in large shafts or use special mucking machines mounted on the shaft wall or on the bottom of the cage. Consider the clamshell for mucking and hoisting in shallow shafts.

Drill to outline shallow shafts, reduce shock in shooting and facilitate mucking.

Drill outlying air shafts, supply shafts and even man and escape shafts.

SINKING METHODS may be influenced to a considerable degree by the type of shaft. Unless shafts are required rather frequently better results usually can be achieved by contracting their sinking, especially if they are large and deep, rather than by purchasing equipment and creating a staff of specialists. Surface facilities and sinking equipment, except for mucking, are substantially the same as in slope sinking, as mentioned. Lining materials, where required,

include sprayed sand-cement and corrugated liner plates for circular openings, in addition to the standard timber, brick or concrete lining.

HEADFRAME UTILIZATION — It is possible to erect and use the final headframe for shaft sinking and lining purposes, though in deep major installations for coal hoisting it may be preferable to erect the headframe afterward. With air and escape shafts, the final headframe is much more easily installed in advance. In one instance the main sheave was centered over the center of a shaft 260 ft deep for the sinking and lining operation. It then was moved to its final position over the escapeway half of the shaft to handle the cage.

MACHINE MUCKING—Muck may be loaded into a standard sinking bucket by hand, though in a multicompartment shaft where a heavy cage can be used in one compartment, new positive-action mucking machines mounted on the cage bottom may be employed (see May, 1955, *Engineering and Mining Journal*, p 82, for example). Machines operating from tracks on the wall of the shaft also have been used to good effect in metallic and nonmetallic mines.

Where the depth is not too great, mucking may be done by a standard clamshell operating from the surface. And if access to the bottom of the shaft is possible, the muck can be dropped through a pilot drill hole into mine cars below.

Where shaft size is sufficient, overshot loaders or loaders of the tractor type speed up the process of getting the shot rock into the sinking buckets for hoisting. In one instance a tractor loader, with the diesel engine replaced by an electric motor, was used to sink a 15x38-ft shaft. Capacity of the unit was 1 cu yd. The rock was shot in 8-ft-deep rounds and then the loader was lowered into the shaft for mucking operation. Eventual depth of the shaft was 430 ft, and the concrete lining was poured as each round was loaded.

OUTLINING BY DRILLING—A new technique in sinking relatively shallow shafts —under 150 to 200 ft—is outlining the shaft by drill holes, using either an overburden drill or a standard borehole machine (*Coal Age*, April, 1955, p 74; June, 1958, p 106). One company, as an example, has put down six shafts up to 160 ft deep at savings of 50% of contract prices. These savings result from a minimum of manpower, simplified excavation and a solid shaft wall that needs a minimum of trimming, plus grouting additives to seal water off more quickly and positively.

Usual practice by the organization is to drill 8-in holes on 24-in centers on the circumference of a circle with a diameter 2 ft greater than the finished opening. Next, blastholes are drilled inside the shear holes. If the finished diameter is to be 12 ft, 10 holes are put down—one in the center and the others evenly around the 12-ft circle. The holes are filled with sand. To shoot a round, about 10 ft of sand is blown out and the holes are charged and fired. The muck is removed by a clamshell on the surface.

Cost of one such shaft was $289 per foot, as follows: drilling, $31; explosives, $8; mucking, $42; concreting, $108.

GROUT SEALING—Chemical additives now increase the effectiveness of grout in sealing off water quickly and positively. In one of the previously discussed shafts, pregrouting was done with chemical additive. After the blast and shear holes were completed grouting holes 10 ft apart were drilled in a circle 10 ft out from the shear holes. Diameter to bedrock was 10 in, in which 8-in casings were cemented. The holes then were extended down to the coal at a diameter of 6 in. The tops of the casings were fitted with 3-in pipe nipples.

Grout with additive was placed in alternate holes and was forced into the strata by air from the regular drilling compressor. Ability to use such compressor equipment is one advantage of the system. With deeper holes, air sometimes may be dispensed with, since grout weight is sufficient to insure penetration.

GEL SEALING—New chemical gels and other materials that have the property of hardening in the presence of moisture and water are finding wider use in stopping seepage or sizeable inflow quickly. The materials are injected through drill holes ahead of and fanned out to the side of the working face. Gel may also be injected after completion of shafts and slopes if water inflows continue or pop up after lining is done. In other words, the materials are quite versatile in application.

SIMPLIFIED LINING—Pouring of concrete linings for the preceding shafts was simplified by a special demountable form spread by a roof jack and held in place by wedges and bolts. In one instance, pipes were placed in four of the shear holes to carry concrete down to the form. After each pour, the pipes were shortened 7 ft. Using ready-mixed concrete, average time for a 7-ft pour was 30 min.

DRILLED SHAFTS—Drilling is finding increasing application as a means of sinking shafts for air and emergency purposes, as well as for handling men and materials on a regular basis. The majority of the units operate on the coring basis, but if pilot holes can be drilled to existing workings new cutting-type units can show even greater speed and lower cost.

Shafts up to 6 ft or more in diameter may be drilled with comparative ease. Costs are moderate. For one 36-in shaft, including pregrouting, roadbuilding and the like, cost was $107 per foot. Depth was 733 ft and the shaft was not lined. Cost of a 48-in hole by the same company, with much more roadbuilding, was $125 per foot. Depth was 975 ft. At least one purchaser of a number of drilled shafts is of the opinion that four or five 60-in-diamater shafts can be bored for the cost of one put down by conventional methods. Diamond-drill holes may be put down in advance for pressure pregrouting of the strata, if desired, and large holes may be drilled in the soft material at the surface to permit casing through the soft layers in advance of drilling the final shaft.

A recent example of the use of cutting rather than coring equipment involved drilling two 76-in shafts (72 in after lining) approximately 530 ft deep—one for ventilation and the other for a double-deck cylindrical cage with a capacity of 20 men.

The two drilled shafts were a much-cheaper substitute for a standard 2-compartment shaft. Advance preparation included grouting the area through small boreholes. Then three 12¼-in holes were drilled—two on 12-ft centers with one between. The middle hole was cased and used for power and water for the drilling operation. It now provides a drainage outlet for water rings in the two shafts and supplies water to the bathhouse and mine.

One of the outer 12¼-in holes was drilled 7 ft into the bottom below the already-developed coal seam and then was reamed to 21¾ in to accommodate a bucket for hoisting cuttings from the drilling of the first shaft. In this drilling, the cuttings were washed into the 12¼-in hole and then were shoveled into the bucket. Next, the 21¾-in hole was drilled to 76 in, with cuttings removal via a larger bucket in the first shaft. Speed in drilling the second shaft often averaged 34 ft in 8 hr.

Nine water rings, feeding to the center hole, were installed in each shaft, and the shafts were lined with corrugated steel, grouted into place, for depths of 330 and 220 ft.

Rock Tunneling

Drill with modern airleg or jumbo equipment for speed and reduced labor in preparation.

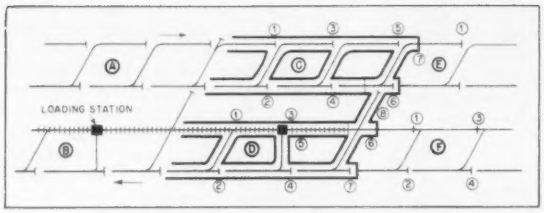
Load with slushers or rock loaders.

INITIAL CUT—In starting a rock tunnel from the outside, it may be possible, as in slope sinking, to use a dragline or some type of excavator to go through the soft material. At some mines, this initial cut has been left open, with the sides stabilized by plating special ground covers. Spraying with a standard sand-cement mixture also has been successfully done to stabilize cut slopes. At others, a concrete section has been installed, as in slopes, and covered with excavated material. Cut-and-cover has the advantage that the material need not be hauled away, compensating in part for the cost of the lining.

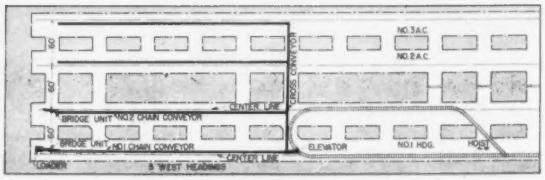
TUNNELING EQUIPMENT — Even though not designed for such duty, coal equipment often is pressed into service where rock tunneling is a special job occurring only once in a great while. The coal equipment, of course, includes loading machines and shuttle cars, and conveyors. As in slope sinking, a continuous miner may be employed if the material is predominately shale or other softer rock.

Where much rock tunneling is required, however, special rock facilities normally are employed. Rock machines include loaders similar to coal machines but designed for rock loading; also over-shot-type loaders and slushers or scrapers of the 2- or 3-drum type, the latter providing a greater degree of flexibility in covering the entire face. The machines may load into rail cars, regular or rock-type shuttle cars or conveyors. Big (15-ton or better) shuttle cars and rock loaders are a popular combination in metal and non-metallic mining.

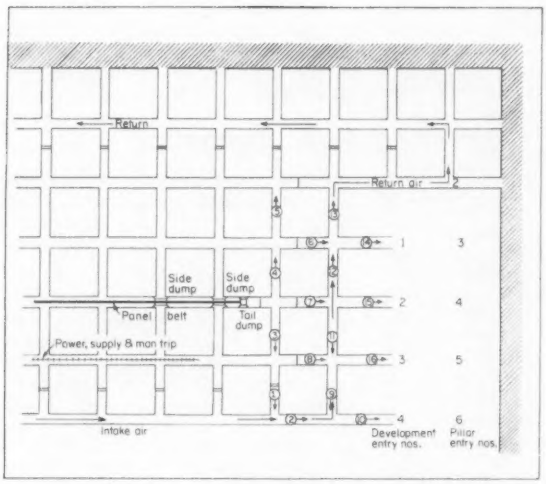
TUNNELING PERFORMANCE—In a 14 x 8-ft tunnel driven with a regular rock-loading machine, average performance was



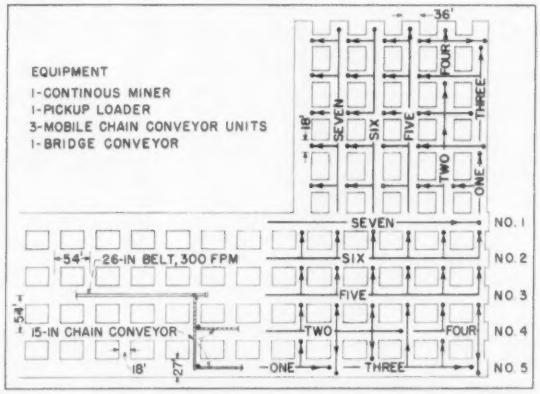
FOUR-HEADING MAIN ENTRY for development with boring-type continuous miner. Alternating from left to right the sequence of advance is shown by the letters and numbers. One objective is to keep shuttle-car tramming distance down.



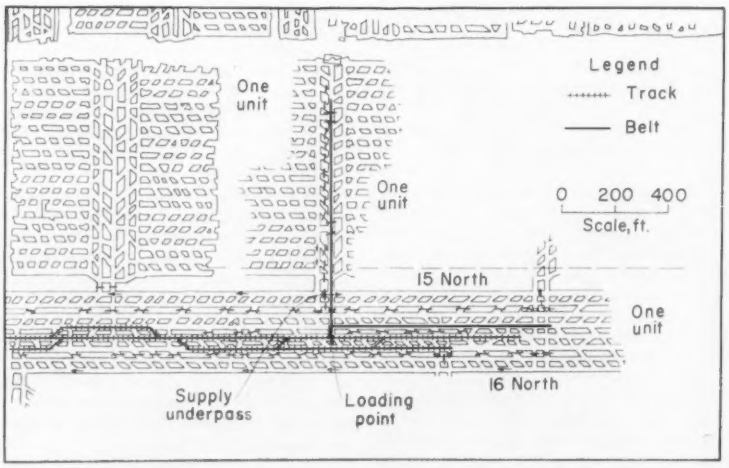
BRIDGE CONVEYOR-LOADER SETUP with loop track for cars is one of the entry-driving systems providing maximum advance with minimum cost. Cross conveyor brings coal from all four places to car-loading elevator.



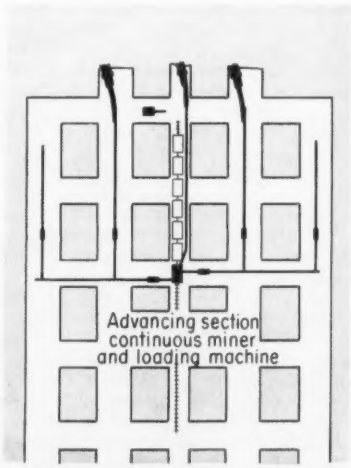
FOUR-HEADING ROOM-ENTRY PLAN for boring-type miner with ropeframe conveyor. Four rows of pillars are removed on retreat out of the section after completion of development.



MINING PLAN with continuous miner, pickup loader, bridge and chain conveyors designed to keep moves to a minimum.

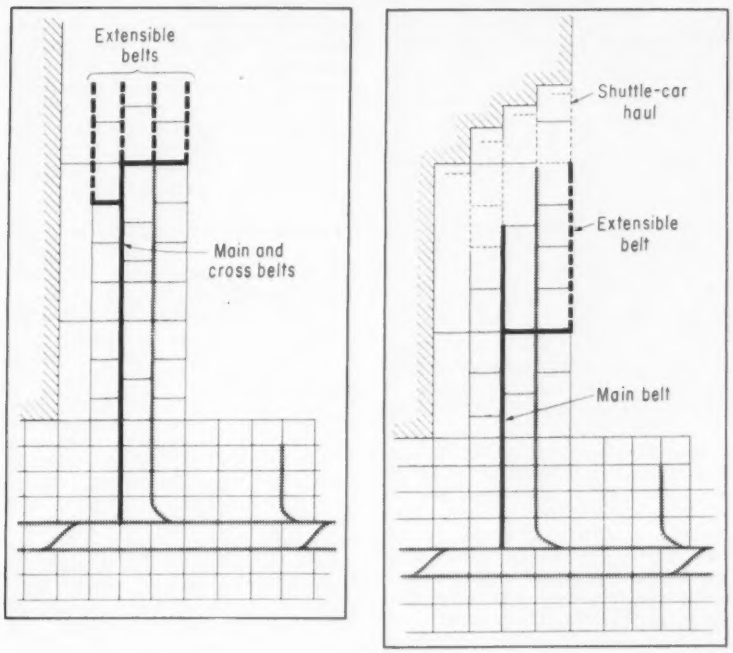


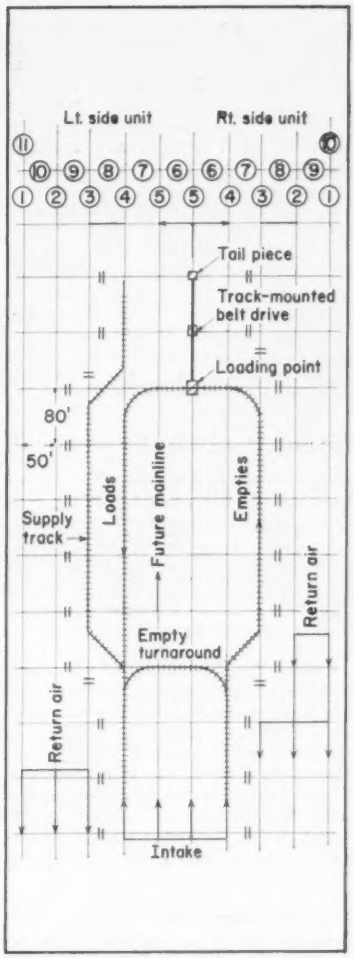
CONCURRENT ENTRY DRIVING features this panel plan with three loading units feeding via belts to a single-car-loading point. Doors and checks are eliminated along shuttle-car hauls.



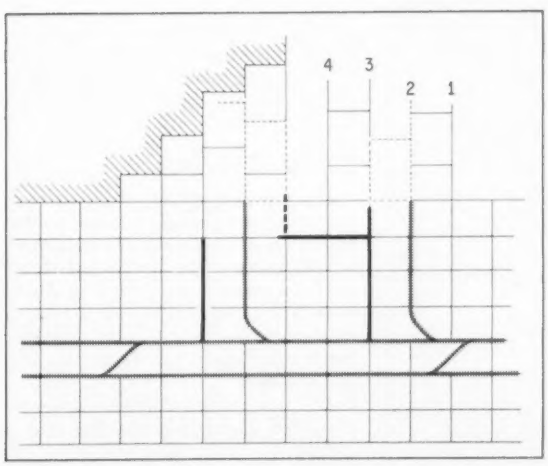
ROCK LOADER advances center heading, and auger-head miners with bridges each pair of side openings.

Development Planbook

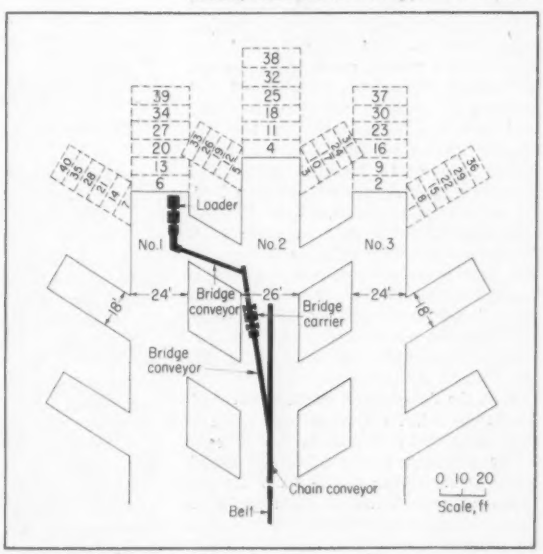




MAIN-ENTRY PLAN shows sequence of advancing headings with two continuous miners, track and belt setup, and ventilation.



FOUR MINERS served by single shuttle cars, extensible belts and cross belts develop four headings (upper left diagram) in this plan. In retreat (lower left diagram), since it is necessary to remove equipment when the roof starts to work, only one extensible belt is used and a second shuttle car or surge loader is used behind each machine. To change from pillaring to development of a new section (lower right) a spare main belt is installed to start the new panel, with a cross belt to permit completion of the old.



FORTY CUTS per loading-point advance without panning up or conventional conveyor moves are possible with this combination of bridge, bridge-carrier and chain conveyors in three-heading setup.

two 10-ft cuts per day of four 6-hr shifts. A four-man drilling and charging crew using two post-mounted drifters normally drilled and charged 26 holes in less than a shift. The cut then was completely mucked on the next shift by a 3-man crew. A ditch 5 ft at the top, 3 ft at the bottom and 3 ft deep was mucked by a hoe-type scraper working behind the rock loader.

In an 8 x 12-ft tunnel with 2 x 1-ft ditch on one side, drilling was done by a track-mounted double-arm jumbo and a car transfer was installed to facilitate switching cars behind the rock loader. The jumbo crew consisted of four men and the loading crew of 3 men. Average distance was 1 ft per hour. At this operation two or more places permitted shifting the machines back and forth.

Mine Projection

Plan for retreat operation, either full retreat from the inside of the mine out or at least in sections or panels.

FULL-RETREAT MINING, meaning mining from the boundary back to the bottom or portal, is the ideal system, with exceptions so few as to be negligible.

ADVANCE AND RETREAT—One compromise providing results frequently as good as full retreat is advance on one side of the mine or working territory and retreat on the other to complete extraction. The basic principle is followed completely if full retreat is practiced in the individual working sections, though here again rooms may be mined on one side of a production entry on the advance, and on the other side on the retreat.

QUICK COAL—Other methods of providing coal while entries are being driven for a full or approximately full retreat system include setting off a special territory well protected by barriers near the bottom or portal, which can be mined, caved and abandoned without risk of affecting the permanent facilities. And where the coal outcrops along a hillside, quick production can be attained by moving in a shovel and stripping the outcrop, not only recovering coal in the stripping operation but also opening up the vein for augering or for deeper recovery by standard underground equipment, such as, a panel belt with loaders or continuous miners, shuttle cars and auxiliaries. If heavy rock or some other handicap makes true stripping undesirable, but conditions are such that benching is feasible and economical, augering or paneling still may be not only a help in development but also a source of considerable low-cost tonnage while the mine is getting started.

With the development of the mining-and-loading machine, the problem of going to full or near-full retreat in the thicker seams —and eventually in the thinner—is materially simplified. This results from the fact that the machine's rate of production is the same or almost the same as when working in rooms.

Contour Development

In mining hilltops and knobs, the panel belt and other modern equipment permits economical recovery at a high rate of production, whereas such areas frequently were impossible to operate when everything had to be done underground. Now, the outcrop is opened by a bulldozer or shovel—the latter normally is required to make the necessary width of bench—and the coal is mined by loading machines and shuttle cars feeding to mother conveyors or panel belts; by continuous miners and extensible belts, and so on. The belts in turn may feed to mine cars on track laid on the bench or trucks. As an alternative, especially where it is desired to work sections large enough to warrant a mainline belt, the coal may be discharged to a semiportable storage bin for trucking to the main plant. By erecting the bins in multiple, it is possible to store the full output of a second shift, for example, eliminating the need for trucks and preparation facilities on that shift.

Section Setups

CLOSED V. OPEN PANELS—One question in setting up a mining section is whether to aim for complete isolation: in other words, a panel completely enclosed by pillars with no openings except for the panel headings. Considerations favoring complete closing of panels include: liability of the coal to spontaneous combustion, and the possibility of breaks in the roof to water-bearing strata. Closed panels facilitate sealing and damming where fires or water breaks occur. The closed panel also facilitates sealing to comply with legislation or the rulings of inspection departments.

Pillaring within a closed panel, however, is more difficult unless conditions are more favorable than those usually encountered. Therefore pillars frequently are left in place where panels are closed, though a number of operations recover them quite successfully. Completely closing panels also cuts down the opportunity for providing alternate escape routes.

Among the benefits of the panel system, whether completely closed or open, is ease in establishing splits for each individual working section. The panel system also lends itself somewhat better to the establishment of bleeder headings—a growing practice where gas emission is heavy and even where it is not for a general improvement in conditions.

PROVIDING BLEEDERS—Bleeder openings may be established in a number of ways. Examples are:

1. In room work on the advance, driving a place from the face of the first room, when it reaches full depth, back to the return of the main or cross entry from which the room entry was turned.

2. Driving a special bleeder entry and escapeway at the tops of room panels, or between panels turned toward each other, and cutting into it by extending the room entries, or by driving over to the bleeder from the faces of the first room or rooms to be completed.

3. Extending the first rooms to be completed to cut into a bleeder opening made by leaving the pillars in at the faces of the rooms in the preceding panel. As each room is cut into the old panel, the old pillar is included in the extraction routine to complete recovery.

Pillaring Practice

A second question in setting up a mining plan is whether to take pillars or leave them. Where the coal is thin, adding to the difficulty of mining, and the top is good enough so that pillar size may be cut down to a minimum, the tendency is to leave pillars. In contrast, pillars also are left in some thick-coal areas because of bad top. Basically, however, taking pillars, unless some special conditions prevent, is desirable to get full return on the necessary expenditures for entry-driving and other development operations. Leaving a third of the coal, for example, means driving, supporting, equipping and maintaining a third more room entries for a given tonnage.

PILLAR SIZE AND SHAPE—As a general rule, these are set by experience with the top, bottom and other natural conditions in the region, with another factor whether or not recovery is immediate. Aside from the weight question, square blocks and a standard width of opening everywhere result in uniform pillaring conditions all the time, thus tending to raise efficiency. Angle driving, yielding "diamond" pillars, substitutes, as a rule, 60-deg turns for 90. Both mine cars and shuttle cars are favored by these gentler turns, but ease of operation in other directions may dictate retention of the 90-deg principle.

Changes in equipment type also influence practice in sizing pillars. Thin pillars between rooms, for example, facilitate cross-cutting and pillar extraction with bridge conveyors. Otherwise, after the reach of the bridge unit is exhausted, an auxiliary cross conveyor and drive would be necessary. Even without special equipment, thin pillars may be desirable for several reasons. To get maximum extraction in first mining, as an example, one operator reduces pillars to two-cut thickness. The final recovery step is slabbing one cut off the pillar and leaving the remainder.

Entry Driving

After providing sufficient airway area, adjust number of openings to needs for other services and to type of equipment employed in development. With loaders and shuttle cars, for example, more is the general rule. With bridge and room conveyors, fewer is the usual rule; likewise with continuous miners regardless of the type of transportation employed.

Load rock mechanically and stow in mine if possible—as close to the loading point as practicable.

NUMBER OF OPENINGS becomes possibly the first question in developing an entry-driving program. In moderate to steeply pitching coal, the difficulties of developing under such conditions normally limit the number to two—a gangway for haulage and an airway above. At a fair number of collieries, gangways in coal have been given up for rock tunnels underneath the vein, though the airway still is made in the coal as a rule, with connections for ventilation and mining through rock chutes. In lighter-pitch coal, conditions are more favorable to increasing the num-

ber of openings, though the general practice still is to keep the number as close to two as possible.

The possibilities of both development and room work with continuous miners in coal under approximately 15 deg have been definitely proved in past few years. In one instance, where the inclination is 12 to 15 deg (*Coal Age*, August, 1956, p 60), ripper-type machines driving gangways and counters across the pitch discharge to shaker conveyors. Rooms are necked from the lower gangway but with the exception of every third one, driven for ventilation, are not cut through until they are needed on retreat out of the panel. The coal is transferred from the shaker on the lower side of the gangway to cars on track laid in the center after the bottom is lifted for the requisite mining height.

WHY MORE HEADINGS—Among the factors involved in establishing the number of headings for an entry in flat-coal mining is airway area. In the thinner seams, especially if the air volume is expected to be large, driving additional openings to keep down velocity yields substantial savings throughout the life of the mine. But even after all the necessary openings for haulage, ventilation and man travel have been provided, it still may be desirable to increase the number. This is especially true with loading machines, and to a lesser extent with certain other equipment. The goal in increasing the number of headings is to make development work as near like room work as possible, which means the lowest cost.

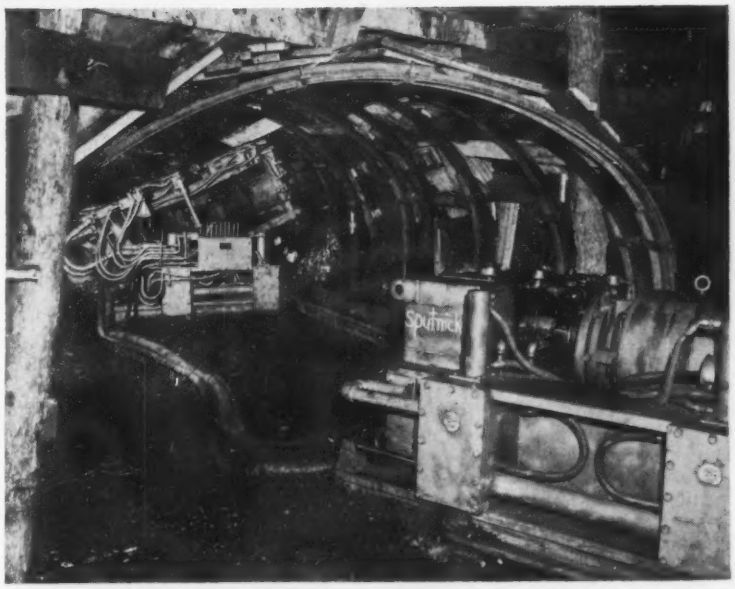
WHY FEWER HEADINGS—The continuous miner and the bridge conveyor, among other new devices, are reducing the need for increasing number of headings for the sake of lowest face cost. A loader in two places equipped with bridge conveyors, for example, often can achieve higher tons per machine and per man, and thus a lower cost, than the same machine with conventional transportation in a considerably large number of places.

With continuous miners, the case is even more pointed since output normally is the same regardless of whether the opening is a room or heading.

ENTRY DRIVING SETUPS—Equipment for entry driving in coal normally is the same in type and general method of use as in other coal work. With mine cars or shuttle cars, any convenient layout for track or transfer stations may be employed.

An example of an entry-driving plan with four headings is shown in an accompanying illustration (*Coal Age*, February, 1957, p 78). In this instance, the mining unit is a boring-type machine served by three shuttle cars, one a surge unit. Heading advancement is in a definite sequence, as shown by the letters and numbers. The basic plan is to advance the headings in pairs to keep tramming time to a minimum and also keep to a minimum the number of crosscuts in the center pillar.

A second four-heading plan for a boring unit (*Coal Age*, March, 1958, p 74) is shown in another illustration. A ropeframe conveyor is used for transportation, and the sequence of cuts is shown by numbers. In retreat (see "Continuous Mining" section) the two rows of blocks from the previous development are picked up, and two rows on the opposite are left next to the solid coal to be picked up in the next stage.



AUGER UNIT shown here in gangway driven by boring unit and protected by yieldable arches, bores ventilation crosscuts up or down the pitch.

A ten-heading plan for two continuous machines is shown in an accompanying diagram. In this instance, the crosscuts between the two center headings serve as the equalizers. If nine headings were driven, as an example, the center place could serve as the equalizer with two units operating.

Keeping equipment moves to a minimum was one goal in another plan for boring-type continuous miners shown in an accompanying illustration. Arrows and legends show the sequence of advance. Rooms in this plan also are driven in similar fashion.

A development plan for auger-head-type equipment, shown in an accompanying illustration, employs five headings. One miner drives the two places on one side, with a second for the pair on the opposite side. Miners drive to the crosscut and through it, then move to the adjoining place.

Track serves the auger-head units in the preceding example. It is, however, being increasingly challenged by conveyors or a combination of conveyors and track, as in the accompanying panel plan. In this instance, one entry-development unit and two room units feed to a single loading point. Doors and checks are eliminated from shuttle-car haulage roads.

Use of a new bridge-conveyor train in entry development with low-type equipment is shown in another diagram in the Planbook section of this feature. The train, plus angle openings, permits loading 40 cuts of coal from one setup in three headings. Then the entire conveying unit, including a self-tramming chain conveyor incorporating the tail pulley of the entensible belt, is moved to the next crosscut. Panning up and conventional conveyor moves are eliminated.

With conveyors, whether loaded by hand or machine, some form of cross unit normally is necessary to bring the coal to one point, for transfer either to a mother belt or mine cars. One layout, based on bridge conveyors (*Coal Age*, September, 1954, p 106), is shown in the accompanying diagram. The cross conveyor brings all the coal to an elevator. Cars are loaded in trips on a loop track, with movement by a hoist.

Instead of the loop track, tail tracks for pushing in and pulling out are common in receiving coal for both conveyors and shuttle cars. Frequently, to get the necessary length of tail section, it is turned into a room or through a cross-cut, with the elevator on the curve.

CROSSCUTTING ON PITCHES — The making of crosscuts between gangways and airways is one of the most costly and aggravating operations in developing for pitch mining. The big drill—36 or 42 in, or larger—has been suggested and used for this purpose (*Coal Age*, May, 1951, p 100). A later unit (*Coal Age*, August, 1955, p 58) is designed for pulling the big bit by a wire rope through a pilot hole, thus decreasing drill size and also weight to a few hundred pounds.

A modification of the highwall auger has recently been employed for crosscutting for ventilation on pitches. The accompanying illustration shows an experimental setup in anthracite. The gangway was driven by a boring-type miner with support by yielding arches. A conveyor removes the auger coal and power is supplied by a separate hydraulic power unit. Holes may be drilled either up or down the pitch.

One advantage of drilled crosscuts is the fact that they are small, though still large enough to carry the required volume of air. Consequently, they can be closed with a simple wood or steel disk, rather than an expensive custom-made stopping of the conventional type.

Continuous Mining

Primary Consideration

A production package—machines, methods, auxiliaries and manpower—matched to mine conditions and operated to provide the minimum in cost with complete safety.

Follow-Through

Development of a mining system matched to machine and mining conditions.

Use of trained men—operators and others—for high output and low maintenance.

Provision for nonstop coal transportation or its equivalent.

Auxiliaries with the necessary capacities to keep them from bottlenecking the miners.

Use of industrial-engineering principles to establish production standards.

Provision for output and other records, including delays, to keep close check on performance.

Roof support without hindering production.

Adequate ventilation for safety and good working conditions.

Rated voltage at the machine for efficient operation and fewer breakdowns.

Expert machine care to reduce production interruptions to a minimum and cut repair cost.

Supplies when needed to minimize production interruptions.

Safety always—not only for its own sake but for greater efficiency.

Practice Trends

Room and pillar almost universally employed, with the square block the most-used extraction unit.

New longwall trials perhaps presage development of a workable type for the U.S.

Increased emphasis on mobile equipment for low coal bringing the day of wide use appreciably closer.

Future Possibilities

Level Coal

A major expansion in the use of remotely controlled miners.

Possible development of hydraulic mining and transporting systems.

Pitching Coal

Hydraulic extraction.

Horizontal slicing with continuous-type equipment and protective canopies.

CONTINUOUS EQUIPMENT, though it usually results in a significant to major cost decrease, is not a panacea for all ills. In other words, it cannot be assumed that it will always give better results than conventional equipment. Natural conditions are a major factor. Among the conditions that might favor conventional over continuous equipment are:

Considerable thickness variations and the presence of heavy partings in some areas but not in others.

Variations in coal quality. Conventional units, where concentration is not so vital, can be scattered to balance the raw-coal output.

Existence of a substantial coarse-coal market. A coarse product also can simplify and cheapen the preparation process, especially if the ash content of the raw coal is such that separate coarse and fine-coal facilities, with thermal drying, are necessary. The coarse-coal facilities cost less to buy and operate.

Heavy spraying with miners can result in dust rideover in preparation, adding to clarification and fine-coal moisture problems.

Capital costs per unit may be higher and productivity less, requiring more miner units and more money, even though higher tons per man are secured.

Usually, however, not all of these adverse factors are encountered at one time, and normally the higher concentration possible with the miner and its smaller crew pays off in lower face cost, especially if the proper follow-through is achieved. Some of the key items in follow-through are as follows:

CONTINUOUS SYSTEMS—Among the basic considerations in developing a continuous-mining plan are:

1. A layout which insures continuous or nearly continuous transportation availability. If shuttle cars are used, for example, it is desirable to provide alternate routes to the transfer station to prevent interference. The changing point, of course, should be as close to the face as possible.

The extensible belt relaxes materially the limits on room depth and also eliminates the changeout problem encountered with wheeled transportation units. Thus, it makes possible special long-room panels, with room depths up to 1,000 ft or more.

2. A layout which cuts equipment moves to a minimum—and keeps the distance down when such moves must be made. The extensible belt, among other things, can, with the proper plan, cut the number and magnitude of moves, along with providing

continuous transportation. Machine type also influences time spent in moving. Machines which drive full width, for example, need not be pulled back every 10 to 20 ft to widen the place.

3. A layout which facilitates getting the necessary air to the working face and eases the dust problem. A full discussion of systems and equipment for attaining these ends appears in the *Coal Age* Special Report, "The ABC's of Ventilation for Continuous Miners," February, 1959, p 97.

Examples of plans incorporating these three principles are featured in the "Continuous Mining Planbook" at the end of this section. A supplement shows various methods of mining individual pillars.

Square or nearly square blocks are becoming more and more the trend, and with it the use of flat or nearly flat pillar lines. Bleeder openings of one type or another are almost invariable practice.

Among the long-room and other "special" plans is the slabbing system under which rooms are driven by boring-type miners, after which the ribs are cut, shot and loaded with conventional loading machines.

Pitching Coal—With some variations depending upon machine type and natural conditions, standard continuous miners can work up and down pitches of up to approximately 20 deg. Entries naturally are driven on the level and rooms are turned up pitch in usual fashion, except for perhaps some modification in centers to facilitate pillaring, if done. Of course, if the continuous miner is limited to entry-driving alone it can be used in coal pitching up to 90 deg.

Suggested plans for using continuous miners in coal pitching more than, say, 20 deg. include driving long places across the strike, using an extensible belt, and then drilling and shooting the up-pitch pillar, starting at the inby end of the place and using the miner as a loader in picking up the coal if it is of the type equipped with loading arms. Otherwise, a standard loader could be brought in for this phase of the work.

Another suggestion is drawing gangways with the miner and then using an underground auger to recover coal in the up-pitch pillar.

TRAINED MEN—This does not mean only formal courses or schooling, though these are growing in number and scope, particularly to meet the needs for maintenance and other special skills. But even without formal indoctrination, the alert supervisor, who will also be the better for training, can do much in instilling good work habits and a proper regard for safety.

NONSTOP TRANSPORTATION — As previously noted, transportation should be continuous or the equivalent of continuous for maximum output. The conveyor is theoretically the ideal from this standpoint, though shuttle cars give a good account of themselves with the proper mining system, and especially if a pickup loader or other surge facilities are employed. Auxiliary mobile conveyors are another development facilitating haulage with shuttle cars.

AUXILIARY CAPACITIES—Other auxiliary units, aside from transportation facilities, must also be matched to the miner to prevent bottlenecks—roof-bolters, for example.

PRODUCTION STANDARDS—Assuming a continuous miner with a rated capacity of 6 tpm will it produce that much every day? Obviously not, but there is a proper figure, which can be arrived at for all conditions by the application of industrial-engineering principles. Production standards established on this basis mean that it is possible to attain the maximum in efficiency. Savings of up to 25% or more in total mine cost have been achieved in this fashion.

PERFORMANCE RECORDS—The need for records will vary, but whatever the variation, the daily, weekly and monthly records finally decided upon should be detailed enough so that present performance can be compared with the past and with the performance of other sections, pits or departments—or better yet with engineered standards. Delay records are as important as production records, since they provide a basis for steps to avoid a recurrence.

ROOF SUPPORT—Aside from safety, the aim in support is installation without hampering production. Bolting units on miners are one answer. Alternating lifts with narrow-head units to permit timber advance in stages, as well as advance of curtains for ventilation, is another.

ADEQUATE VENTILATION—Because speed of advance increases gas emission and dust formation, positive means must be employed—brattice lines, auxiliary fans, etc.—to keep the face clear and gas and dust below the hazard levels. Yet too much air results in discomfort. Spraying and rock-dusting become much more important. Also, as a result of higher gas and dust formation, care must be taken to insure good rock-dusting in return airways.

RATED VOLTAGE—Voltage lower than the nameplate rating not only slows down equipment, particularly DC; it also breeds a don't-care attitude among crew members and results in more trouble and higher maintenance. Good voltage at the machine means good power—a vital factor in performance and cost today.

EXPERT MACHINE CARE—Low cost today depends on keeping machines running as much of the time as possible at rated capacity. Stoppages resulting from machine failures cost as much in idle time as any other interruption. Skilled preventive attention is the answer.

SUPPLIES WHEN NEEDED — Small breakdowns can have severe consequences when it is necessary to send to some distant point for a part that should have been in the production area. The moral is to make sure that supply items of the right type are at the right place at the time they are needed.

SAFETY ALWAYS — Last but by no means least in any set of principles for running a mine or section is constant emphasis on safety. The payoff comes from not only reduced accident costs but from the fact that safe methods are efficient methods—and safety-minded men are better producers.

Field Reports

Full Pillaring With Boring-Type Equipment—Evolution in mining plan and transportation equipment in 96-in coal, with 7- or 7½-ft mining height, results in an increase from 376 to 621 tons per machine-shift in 34 mo. Final stages were adoption of flat pillar line and rope-frame conveyor. *Coal Age,* March, 1959, p 74.

Remote Control—Developed for use in pillaring with ripper-type equipment, control unit plus programmed swing permits operation from 50 ft away. *Coal Age,* August, 1959, p 98.

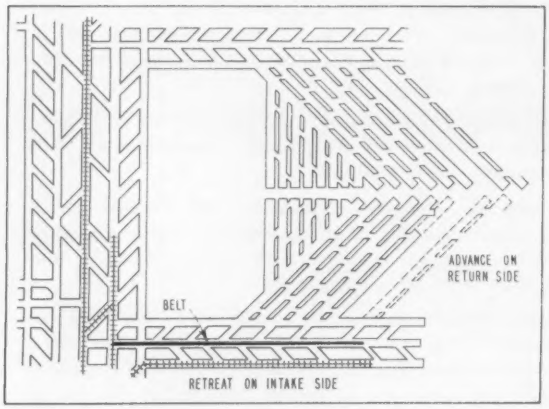
Underground Augering—Recovery of thin veins not otherwise profitable to mine and selective mining in areas of heavy partings are goals in use of self-moving auger. In clean coal, 100-ft hole yielding 23 tons is drilled in 1 hr. *Coal Age,* November, 1959, p 76.

Twin-Head Borers—Recovering 8-ft coal at new mine, twin-head machines have exceeded 760 tons per shift. Mine design features full retreat with haulage by 50-ton locomotives to 1,600-ft slope belt with a capacity of 1,680 tph at 625 fpm. *Coal Age,* December, 1959, p 78.

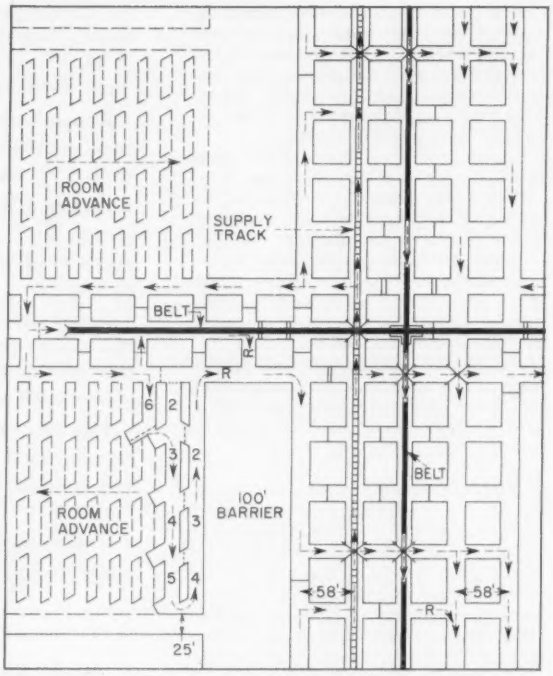
Thin-Seam Production—Auger-head miners in 31-in coal raised section from 8.75 tpm, hand loading, to 21.84 tpm. In advance work, productivity rose from 8.56 to 16.56 tpm. Units are served by bridge and room conveyors. *Coal Age,* February, 1960, p 98.

Thin-Seam Longwall—Moroccan experience with low-type Russian miner on longwall in coal 2 ft thick or less. *Coal Age,* June, 1960, p 88.

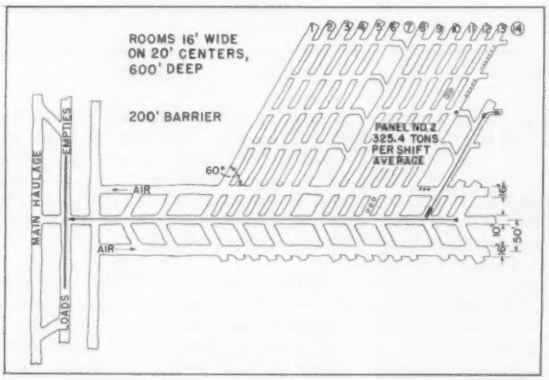
Continuous-Mining Planbook



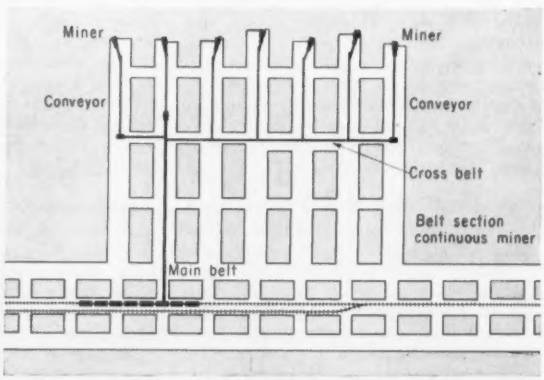
ANGLE PLAN with shuttle-car and belt haulage. Rooms are worked advancing on the return and retreat on the intake. Stub rooms are driven to mine the triangle formed in this project.



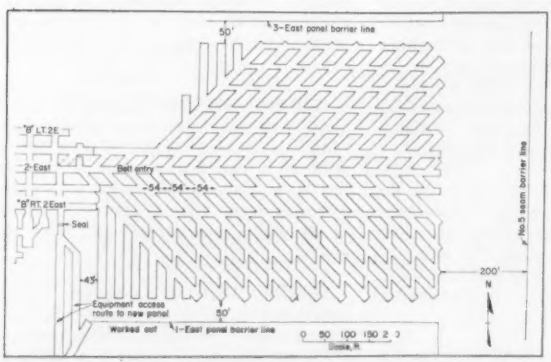
45-DEG TURNS permit full utilization of boring head. Rooms and pillars are mined on one side advancing, and on the opposite side retreating. Mining is always toward fresh air.



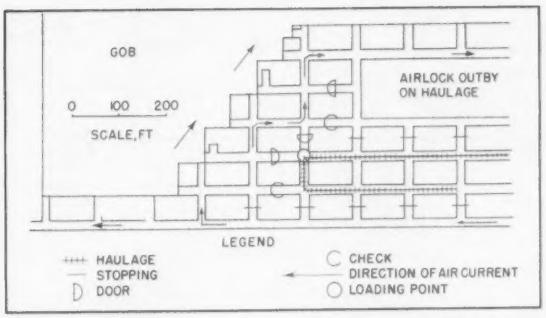
ADVANCE ON ONE SIDE of the panel and retreat on the other distinguishes this room plan for ripper-type units. The mining sequence in the first two rooms establishes the cross-cutting pattern for subsequent places.



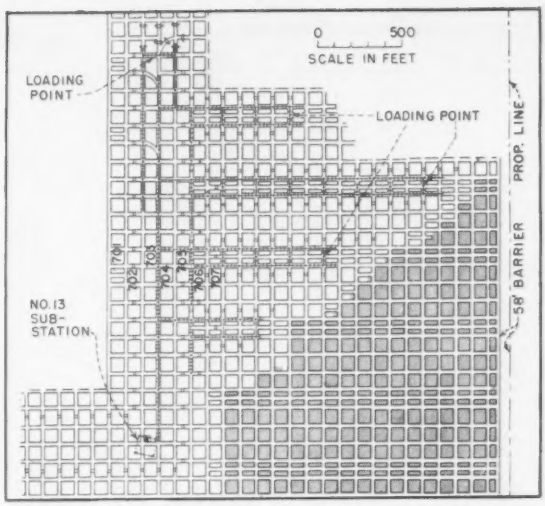
PLAN FOR AUGER-HEAD MINERS is based on driving seven rooms. Miners discharge to bridge and room units feeding to cross and main belts. The coal is thin and pillars are not recovered.



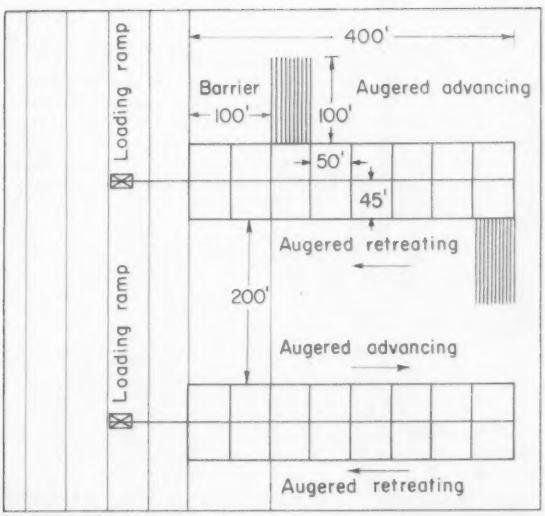
ANGLE PLAN with haulage by extensible belt, advance on one side and retreat on the other, ripper-type machines. Rooms are 600 ft deep.



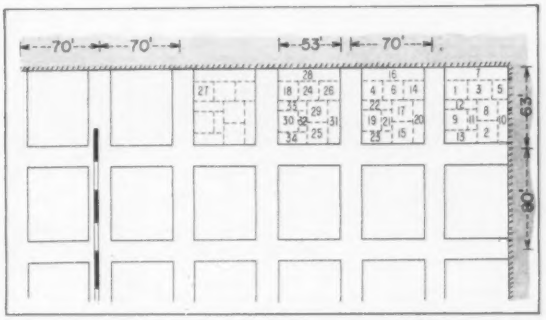
"SHORT-ROOM" PLAN for semirigid head machines employs rectangular pillars. There is little basic difference between development and room work in this system. Loop track facilitates haulage from shuttle cars.



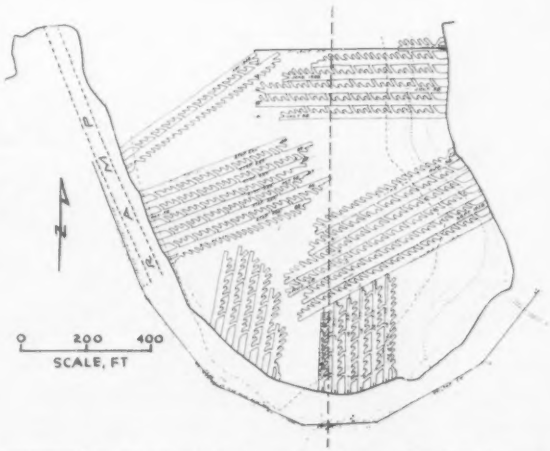
STEPPED PILLAR LINE—Long pillar lines are the exception rather than the rule, and where used frequently are stepped, as in this plan, each step constituting a section for a ripper-type unit. Loop-haulage system eliminates car-change delays at loading points.



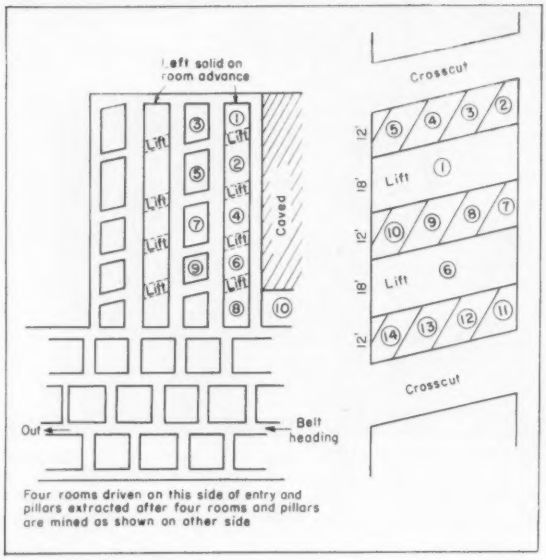
UNDERGROUND AUGER SYSTEM involves drilling on one side of panels on the advance to depth of 400 ft and then retreating on opposite side. Auger holes are 100 ft deep, with 6 in between.

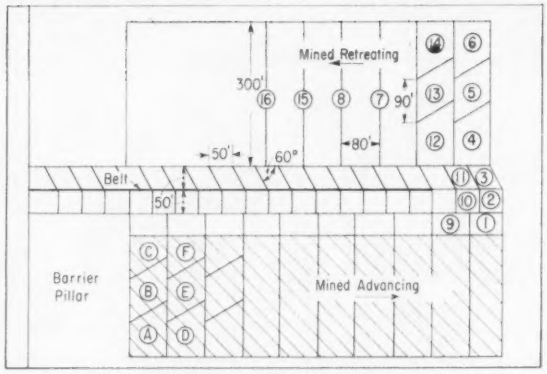


BARRIER RECOVERY PLAN (barriers 500 to 700 ft thick) with semirigid machine. The rectangular blocks are mined from two sides in the sequence shown.

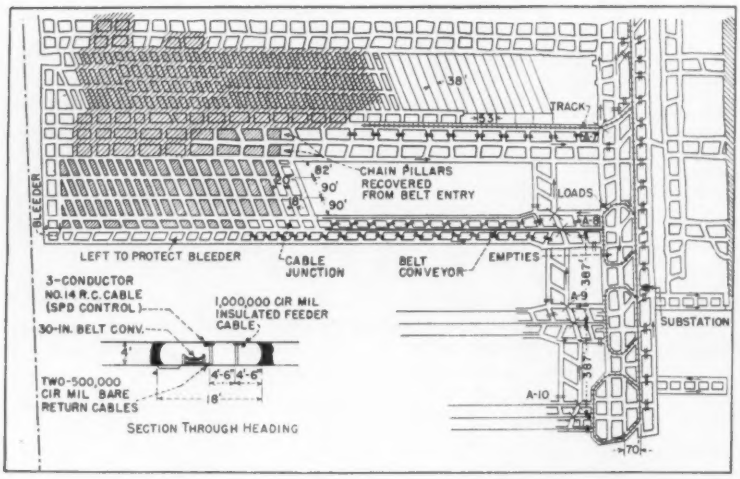


HIGHWALL PLAN for boring unit and extensible belt features flexibility in room direction and depth. Bad top requires careful support.

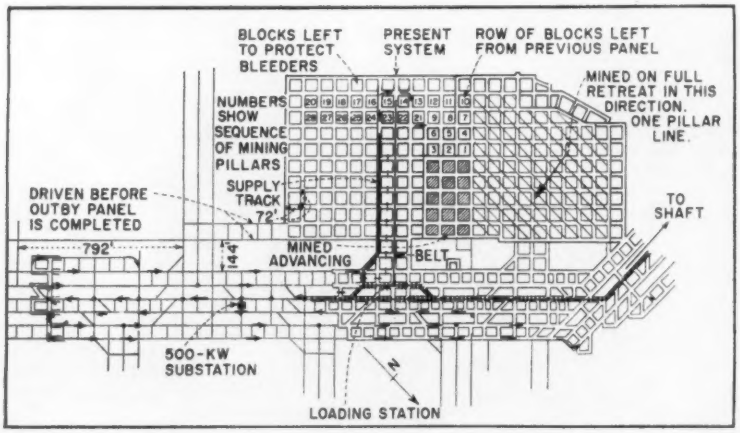




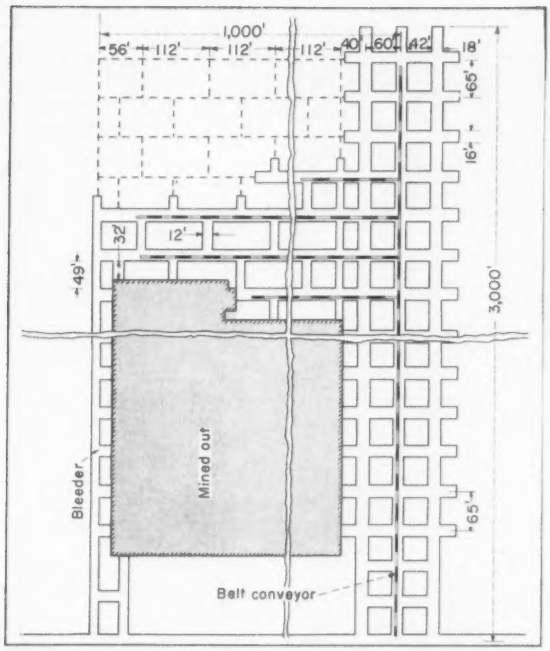
ANGLE CROSSCUTS feature these two plans, one for advance on one side and retreat on the other, and the other for retreat by alternating from side to side four-room groups. Letters and numbers show sequence of development and pillar removal.

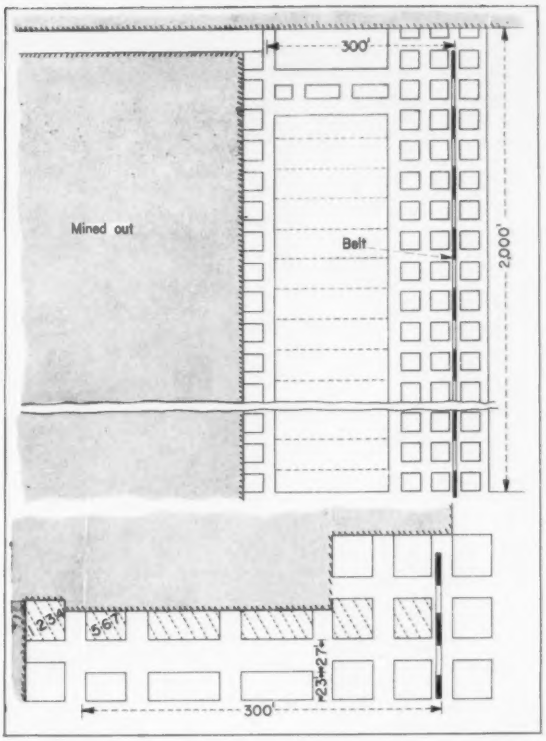


ANGLE DEVELOPMENT with rooms on only one side of the panel features this retreat-mining plan for boring-type miners in medium-thickness coal. The miner changes from one place to the next of two each time it reaches a crosscut. Thin pillars are mined open-ended when a room is completed.

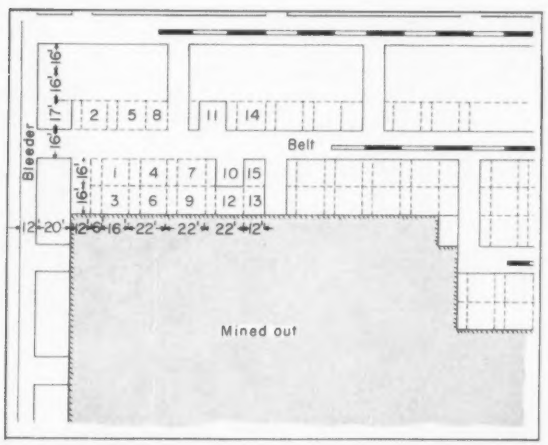


ADVANCE ON ONE SIDE OF THE PANEL and retreat on the other features this plan designed for a minimum of open territory. Two rooms are always kept open ahead of the advancing pillar line by driving a new place as soon as each line of pillars is completed.

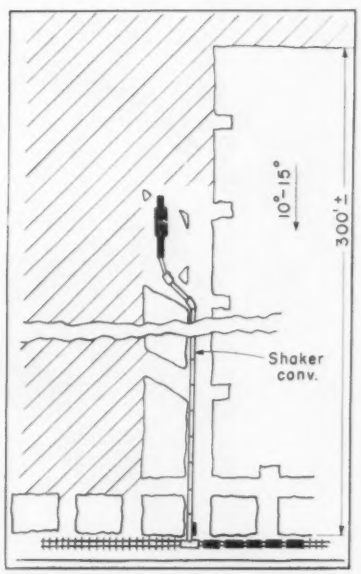




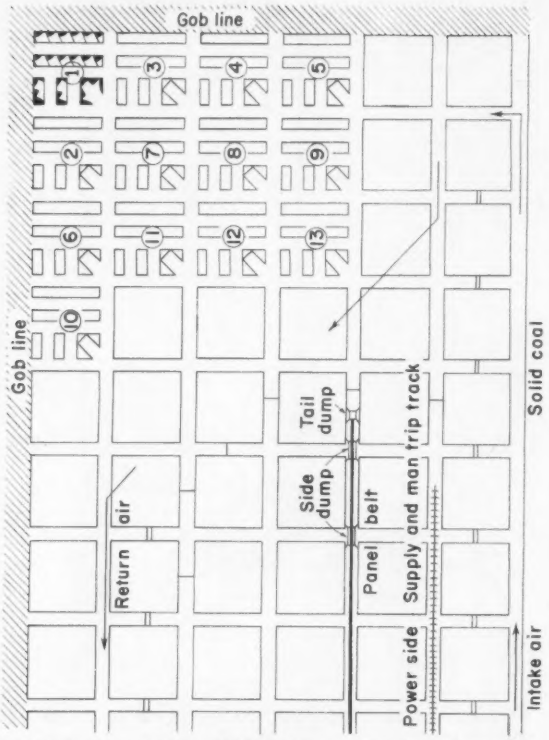
ANGLE-PILLARING PLAN for boring-type miners in 40-in coal. The first two rooms are driven abreast to establish ventilation. Then rooms are driven and pillars are mined on the angle as shown.



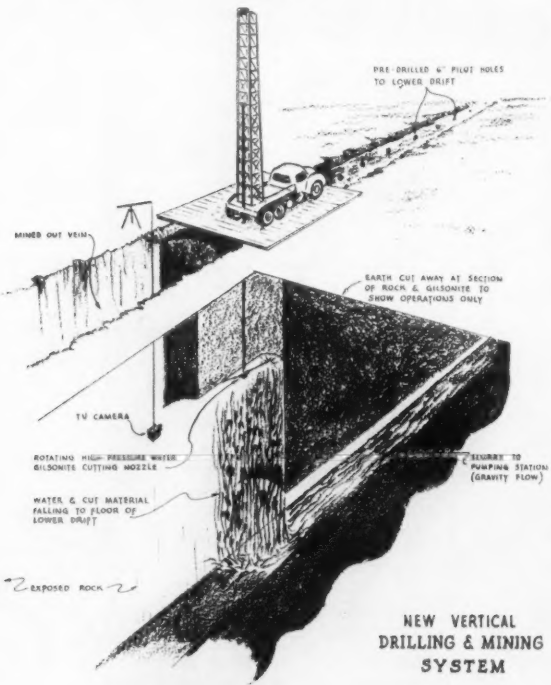
RIPPER-MACHINE PLAN for 66-in coal, sections 2,000 ft wide and 3,000 ft deep, mined advance and retreat. Alternate right- and left-hand pillar extraction is practiced, with pockets driven as in the view below to complete recovery. The miners discharge to extensible belts equipped with bridge conveyor. Coal recovery is about 90%, and good pillar falls are secured.



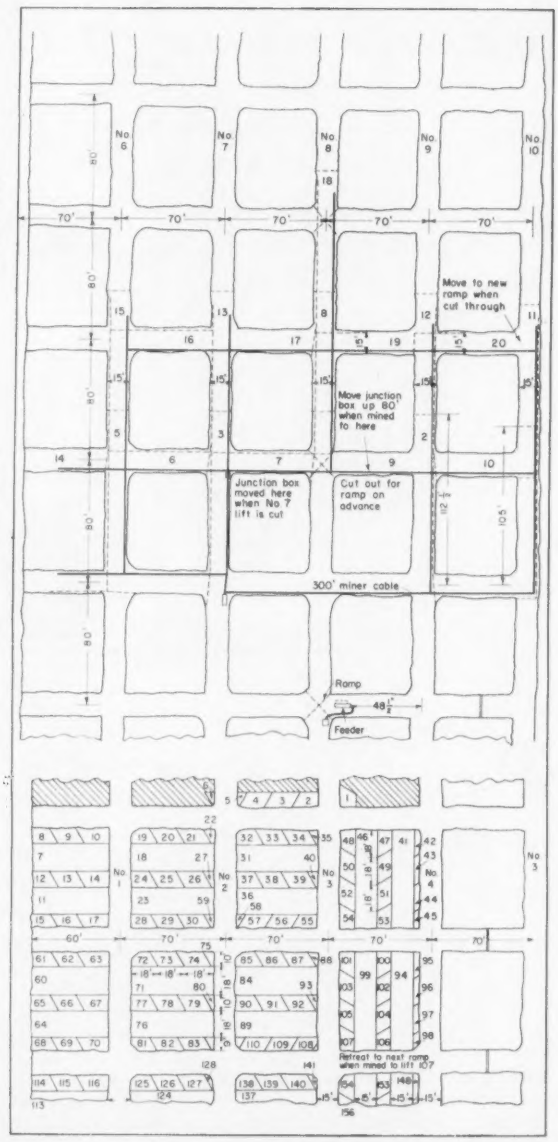
PITCH PLAN for ripper-type machines in 12- to 15-deg work. Blind crosscuts are used for supply storage. Conveyors bring coal down to cars on the gangway. The counter is used for miner travel.



INDIVIDUAL PILLAR RECOVERY on a flat line features this plan for a boring machine with shuttle cars hauling to an extensible belt. Pillar removal sequence is shown in diagram in the "Pillaring Planbook."

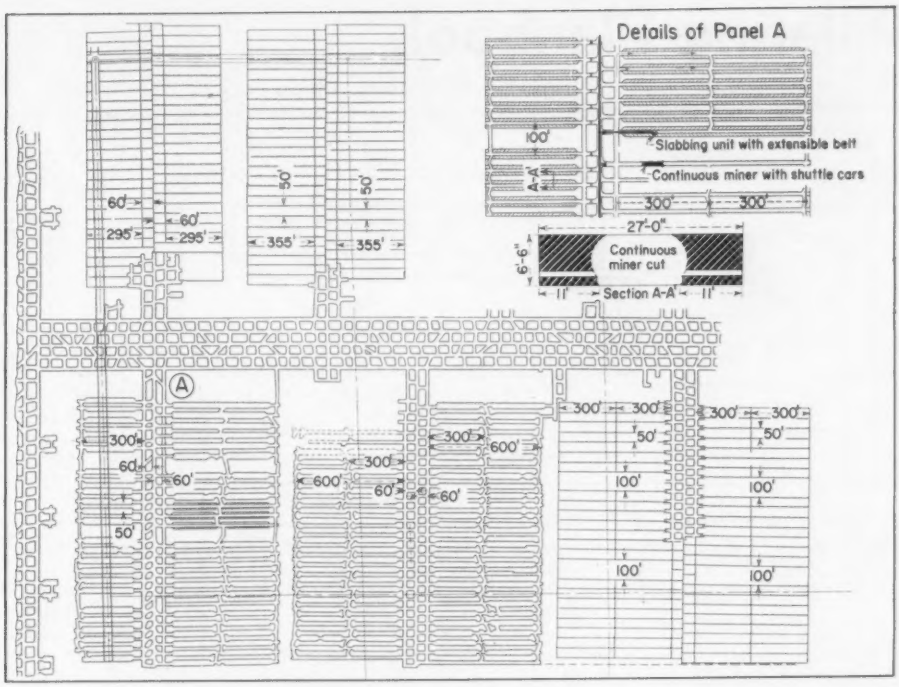


ONE FUTURE HYDRAULIC APPLICATION? New plan devised for vertical gilsonite vein uses cutting nozzle lowered down boreholes.

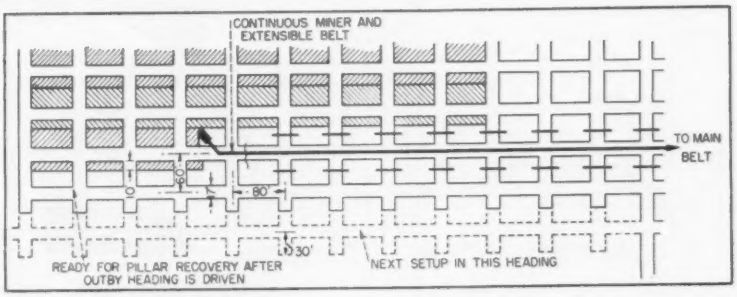


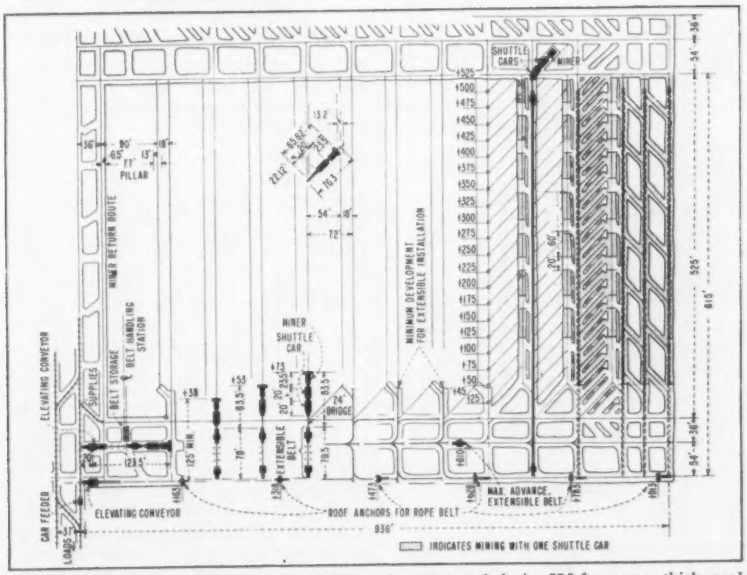
KEEPING EQUIPMENT MOVES DOWN was a major objective in this mining plan for thick coal and ripper-type machines with shuttle-car service. Strict adherence to driving sequence limits equipment moves. Pillars are removed one at a time by 18-ft lifts leaving 10-ft fenders. Bolting units are mounted on the miners. Average output is 43.6 tons of clean coal per faceman.

SLABBING PLAN uses extensible belts with boring-type miners to drive 600-ft rooms with one crosscut halfway up and another at end, using blowers. After miner moves, room is center cut 11 ft deep on both sides, and the coal is shot and placed on belt by crawler loader.



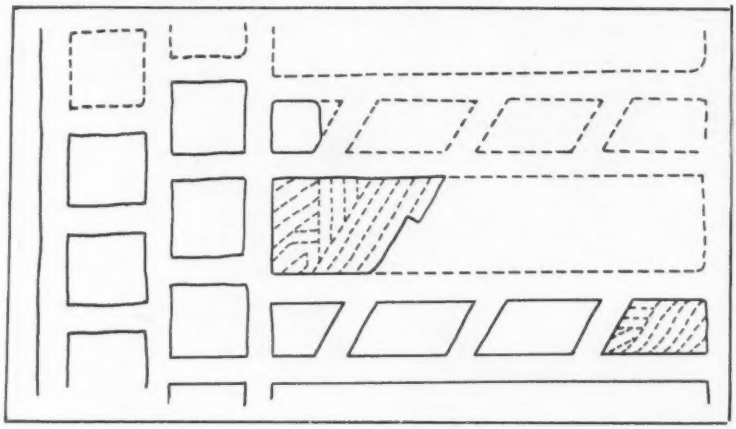
EXTENSIBLE BELT PLAN for ripper-type miners permits driving places 1,000 ft deep. When the place is driven the miner takes 10 ft off the pillar on the solid side and then completes the pillar on the gob side. When extraction is completed, the miner leapfrogs the next place (already driven) and drives up the third one. Miner and head and tail sections of the belt then return to complete No. 2, in which extra belt and stands are in place.



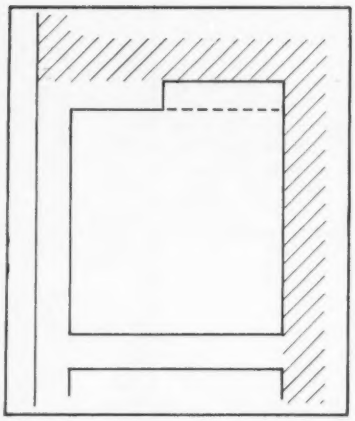


MINING WITH BORING-TYPE UNIT and rope-type belt in 525-ft rooms, thick coal. Pairs of rooms are driven on short centers and pillars between pairs are mined by angle lifts. Chain pillars are recovered with two shuttle cars.

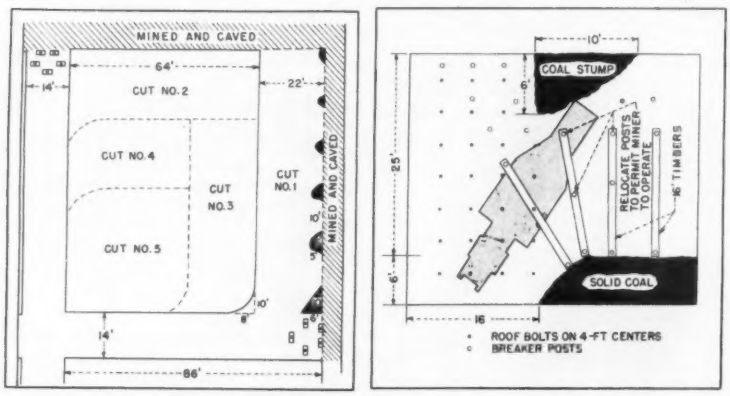
Pillaring Planbook



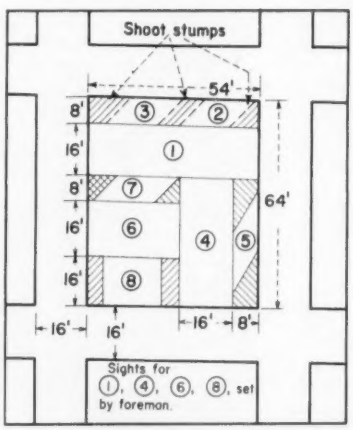
ANGLE OPEN-ENDING combined with 90-deg development. Top is medium hard and places are driven 16 ft wide on 50-ft centers with boring-type miner. Solid pillars between pairs of rooms provide much of the tonnage. Angling favors the boring-type continuous machines.



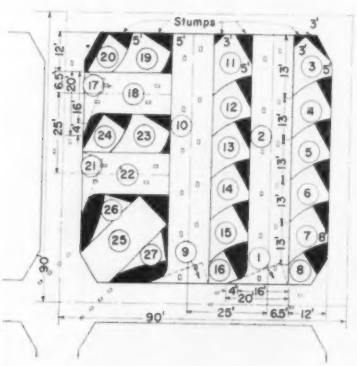
CONVENTIONAL OPEN-ENDING is one of several types employed in continuous mining and is facilitated by speed of extraction, in turn easing the support problem. Simplicity is another feature, not only in mining but in ventilation and moving of equipment.



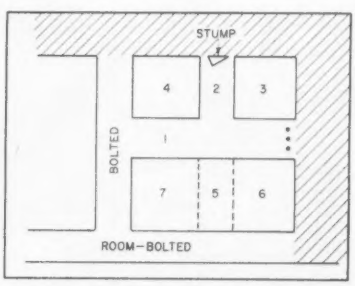
OPEN-ENDING WITH SMALL COAL STUMPS for additional support and protection of the lift across the pillar. The stumps supplement roof bolts and crossbars placed as in the right-hand diagram. Ripping-type machines are employed for the mining operation in thick coal with a drawslate top.



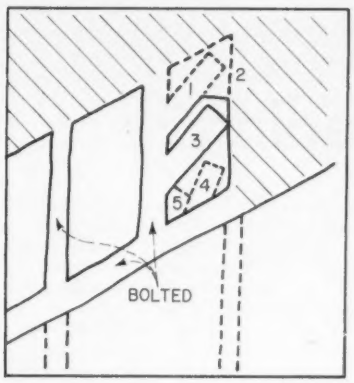
ALTERNATE LIFTS are taken from two sides of the pillar in this plan for ripper-type machines in thick coal with drawslate top, roof-bolters on the miners. The 8-ft wings are removed by cutting through at intervals and shooting the stumps.

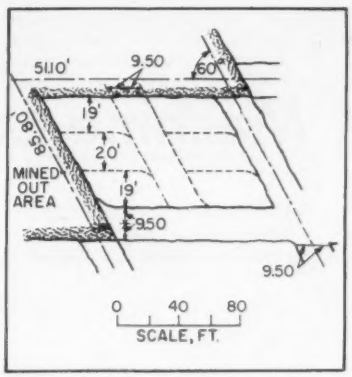


POCKET- AND WING-PLAN for boring machine shortens tramming distance, eases cable handling, cuts mining on the butt cleats, and facilitates shuttle-car haulage.

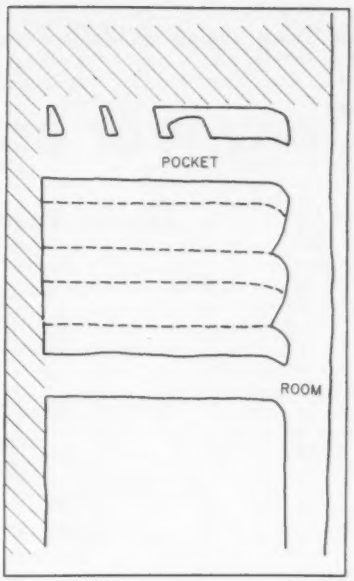


SPLITTING in its various modifications is a popular form of pillar removal. Normally it provides the maximum in coal for holding weight until final wing or stump removal. This conventional plan leaves big corner stumps plus a small triangle in the secondary split for protection.

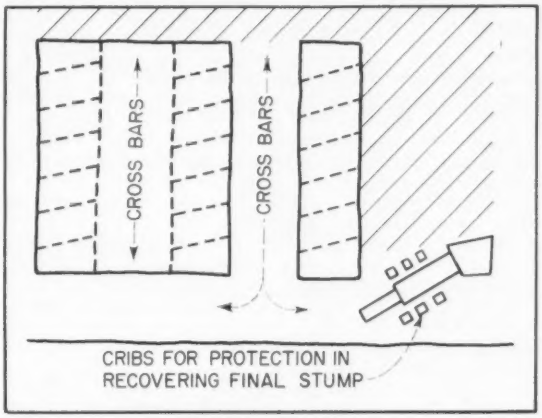




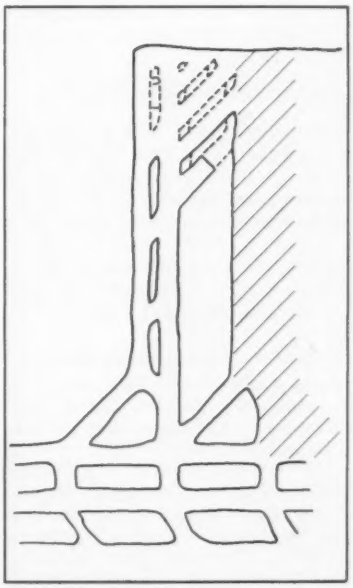
SPLITTING PLANS FOR DIAMOND-SHAPED BLOCKS. Left view shows 60x70-ft blocks, 4- to 6-ft coal, firm shale top, boring-type miners. Fast extraction permits recovering two halves with posts only. Right view, semirigid machines, shows splitting on shorter axis recovering halves open-ended. Square blocks also can be mined with similar plans.



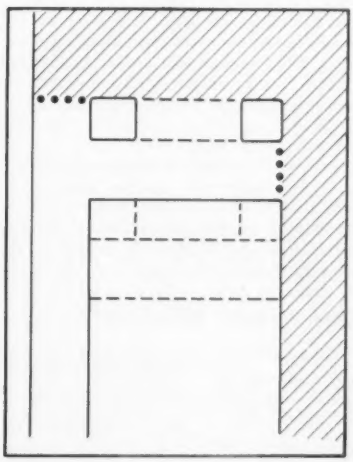
WINGS in this pocket plan for ripper-type machines are formed in 85x85-ft blocks by driving places 15 ft wide to leave wings 10 ft thick. These are cut through at intervals to leave small stumps. Roof is top coal and drawslate held by bolting.



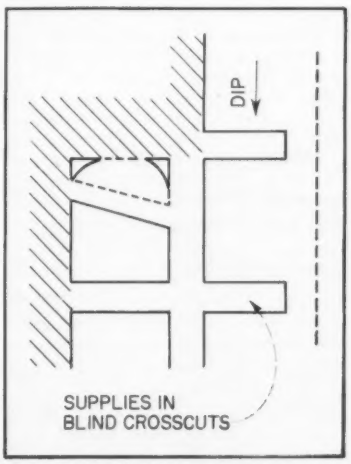
WINGS ARE OPEN-ENDED in this splitting plan for drawslate. Semirigid miners are employed. Bars in splits are held at the gob end by bolts and, at the solid side, by posts, which remain and act as breakers when the next split is mined. Limiting posts to only one row also reduces interference. Cribs are set on each side of the miner in taking the final pillar lift.



ANGLE POCKETS with thin fenders rather than thicker wings distinguish this plan of mining. Basic development with boring-type equipment is on 90 deg. Rooms are driven in pairs and the thick pillars between pairs are removed by subsidiary pockets. The final operation is splitting the chain pillars and fenders, as shown.



POCKET PLAN of the conventional type includes wings which are split to leave final stumps.



SLANT POCKET is employed in pitch-mining plan with ripper-type machines. Final extraction involves splitting wing on the upper side. Inclination is 12 to 15 deg.

Conveyor and Machine Loading

Starting Points

Use of the highest-capacity equipment available for the conditions at the property.

Maximum production per unit and per man through modern mining plans and operating practices.

Follow-Through

Careful study of available equipment types and installation of the highest-capacity units matching mine conditions.

Emphasis on the development of mining systems that will provide an opportunity for the equipment to produce at as near maximum rate as possible the entire shift.

Providing the loading unit with supplementary units of the proper capacity to prevent bottlenecking and delays to the loading operation.

Achieving a cycle properly balanced in all its elements, this also to prevent bottlenecking and delays.

Practice Trends

Integration of the loading unit with matching transportation facilities, particularly bridge and extensible conveyors.

Closer control of cycle and intensive preventive maintenance to increase productive time.

Equipment Selection

THIN COAL—New loading machines are being designed to get down into fairly thin coal and should be used where possible. If loaders are not feasible, use self-loading conveyors, other things being equal.

THICK COAL—Use the highest-capacity loading machines and transportation units available, other things being equal.

PITCHING COAL—Use conventional conveyor or mobile equipment up to 8 to 10 deg, conveyors up to 18 to 20 deg, sheet iron up to around 30 deg and longhole drills on the steeper pitches.

MOBILE EQUIPMENT, since it is inherently higher in unit capacity and thus more economical of labor, ranks first in choice among available types of loading units. Loaders now are available for operation in coal as thin as 3 ft or slightly less. Matching auxiliaries include the articulated shuttle car as well as the extensible belt, both tending to further increase the productivity of the face unit. Very-soft bottom is one of the few possible bars to the use of mobile equipment.

At the other end of the scale loading machines with extra-high capacity, and with auxiliaries designed for the job, have been made available for mining up to 15 ft or more in coal height.

CONVEYORS—Under 36 in and almost certainly under 30 in at the present time, practicable mechanical devices are conveyors and scrapers, the former being preferred. Self-loading heads on the shaking types of conveyors convert them into true loading units.

Where to Find It . . .

Equipment Selection . . . . . p 220
Thin coal . . . Thick coal . . . Pitching coal

Conveyor Mining . . . . . p 220
Cutting moving time . . . Conveyor projections . . . Unit organizations . . . Scheduling face work

Machine Mining . . . . . p 222
Machine projections and plans . . . Shuttle-car, track and conveyor haulage . . . Pillaring systems

Pitch Mining . . . . . p 228
Light pitch . . . Moderate pitch . . . Heavy pitch . . . Longholing . . . Boring crosscuts

PITCHING COAL—Conventional conveyor and mobile equipment can be used with a high degree of efficiency up to approximately 18 to 20 deg. At 10 deg or less there is only a slight difference in results, if any. Where haulage is concerned, the breaking point where conveyors usually must be substituted for rail cars or shuttle cars usually is around 5 deg. However, rubber-tired equipment has been used in crosspitch rooms or chambers to around 12 deg. The maximum pitch on which mobile machines may be employed is yet to be determined though up to 18 to 20 deg has been achieved.

Explosives and gravity remain the major production tools where greater than sheet-iron pitches are encountered. To make it possible to bring these forces into play with a minimum of labor the longhole drill is being increasingly used.

Conveyor Mining

Concentrate conveyors into groups of two and preferably four or more.

Drive up first and mine rooms and pillars on the retreat. An acceptable alternative under most conditions is advance on one side while driving the entry and retreat on the other.

Schedule operations at the face so that loading is carried on with a minimum of in-

terruptions for cutting, drilling, shooting, timbering and so on.

Select mining plans that cut moving time. Try to buy or redesign all types of conveyors to facilitate moving and save time. Use pullers or carriers—home-grown or purchased—to ease the moving job.

CONVEYORS normally are used in groups of two to four, although the variations are almost infinite. The benefits of grouping are those usual with concentration. Single conveyors are found mostly in pitching coal, and in second or third mining of anthracite. And whether single or multiple, in rooms or in entries, conveyors usually discharge either to a panel belt or to a gathering or cross conveyor concentrating the output at a single car-loading point.

Without a flexible joint or a face unit, practicable room width with hard loading usually is 16 to 18 ft. With face units, rooms can be driven 50 ft, 60 ft or more in width where roof and other condition are favorable. Wider faces ease the problem of arranging the cycle so that loading proceeds with minimum interference and maximum efficiency. And even though the face conveyor is longer, putting it on wheels or rollers and designing the joints for quick breaking and making (*Coal Age*, October, 1952, p 77, for an example) permits rapid moving even where close timbering is necessary.

A face unit with a shaker is employed in each of a pair of rooms in an accompanying conveyor plan. It is used to mine 40 ft wide as the room is driven up, and then is turned to mine another 40 ft on the way back.

SWIVEL AND TURNS—With shaker conveyors, swivels make it possible to swing the face end rather readily, provided jacks and posts do not interfere. Thus, within limits it is possible to widen the place without going to face units or turning the trough. At the same time it is possible to keep the face end of the conveyor in the most favorable position for hand loading. Ability to use swivels and turns permits driving crosscuts and working pillar places without separate drives. Bellcranks also permit operating separate trough lines from the main unit as desired. Uphill types with curved discharge chutes also can lift coal or rock and load it into cars without auxiliaries.

Adding a duckbill or sawbill makes the shaker conveyor self-loading. Power swing and power advance and retract also are available on duckbills. Compared to loading by hand, adding a duckbill, sawbill or power duckbill increases the number of cuts that can be mined in a shift by from one to three, thus, in some instances, as much as doubling the output per shift.

Cutting Moving Time

One of the biggest headaches in the use of conveyors of the conventional type is not only extension time but also moving time. Though there are not too many, some methods for saving in moving time do exist. As previously noted, equipping face conveyors with rollers is one. Couplings that are quick to lock and unlock, and special tools for breaking and joining chains are among them.

The time-consuming and costly job of moving from one place to another can be materially eased by at least certain steps, including the following:

1. Turning the moving job over to special crews.

2. Using pullers and carriers to eliminate most of the physical effort and much of the time involved in shifts from one place to another. Shortwall trucks of the crawler or rubber-tired types can be used for carrying or towing or both. Or pullers and carriers specially designed for the job, including the necessary winches, may be purchased or made.

3. Using mobile drive sections. These mobile sections, mounted on crawlers, have made it possible to move an entire room unit completely in as little as 1½ hr.

MODIFIED MINING PLANS—Certain mining systems help in cutting down on charges for moving conveyor parts and such materials as crossbars and the like. If only one place is worked at a time, as an example, blind cross cuts may be driven toward the next place, and pans, chain and materials may be stored in them for pickup as the new place comes up to the crosscuts. Or, the conveyor line may be left intact in the old place to permit pans to be taken off as needed and moved through the crosscuts.

Special mining plans designed to reduce moving time include the "continuous-room" setup shown in the Planbook later in this feature. One place, it will be noted, serves as a beltway with a cross unit bringing the coal over from the others. When the "rooms" have advanced the set distance, another cross unit is installed after the drives for the room conveyors have been moved up. Moves thus are made straight ahead and over a minimum of distance, reducing the time requirements.

"Panning up," or conveyor extension, when done section by section, interrupts face operations and requires both time and labor. The bridge conveyor is one method of reducing the number of interruptions and the time required. In fact, the first bridge unit was developed to reproduce pan-up time in hand loading, but was quickly adapted to carrying coal away from loaders and continuous miners because of its manifest advantages. Now, bridge conveyors are supplemented by bridge carriers, mobile conveyors and extensible belts to eliminate all panning between crosscuts, and most of the usual moving operations.

Conveyor Plans

The plans adopted for conveyor mining are as numerous as the variations in equipment units, but the most-used ones are two:

1. Driving the room entry up the full distance and then working rooms on one or both sides on the retreat. If the mining is done on both sides of the panel, one equipment unit may alternate, or matching units may be used on both sides.

Where the coal pitches and entries or gangways are driven on the strike, places are turned up the pitch. Occasionally (see Mechanical Mining Planbook later in this feature) a sub-opening may be established up the pitch to permit two or more groups to be operated in cascade fashion. A variation is driving stubs up the pitch, equipping them with proper lowering equipment, then turning rooms across the pitch starting at the top of the stub and working down.

2. Developing the room entry and at the same time working rooms on one side of the advance, then completing the panel by retreat on the opposite side, is another common conveyor system. This normally results in a more even output over the life of the section, and also keeps all working sections on the fresh-air side of the panel ventilating system. In driving and advancing on one side, the entry, as shown in the accompanying plan (see Planbook), may be advanced a certain distance and then the equipment moved into the rooms to mine them out, after which another entry advance is made.

In any system, most operators like to prepare room necks in advance. Thus, if the entry is completely developed in advance places may be necked 2 to 3 cuts on one or both sides to be ready for final mining—that is, with a two-heading entry. However, if chain-pillar crosscuts are made on room centers necking may be unnecessary on one side. And with a three-heading entry, with the belt in the center, crosscutting on room centers can eliminate any necking on either side, though many operators still feel that it is worth driving in to the point where room widening starts. Also crosscutting on such short centers may be undesirable from several standpoints, including extra stopings and more likelihood of roof trouble.

PILLAR EXTRACTION — Where the coal is under 3 or 3½ ft and the top permits, many operators prefer to reduce pillars to a minimum and leave them, some arguing that the value of the coal left is less than the cost of the timber that would have to be put in to recover it. In at least one instance part of the pillar is pocketed out and the remainder left to protect the next pocket, eventually crushing with subsidence of the top. Where pillars are taken, usual practice is to widen to one side only, putting the conveyor along the straight rib where it is close to the pillars to be removed.

Unit Organization

In addition to the room and—possibly—face and cross conveyors and elevators the usual practice in setting up a conveyor unit is to put a shortwall cutter and a drill in each place. Attempts to move cutters from place to place make it difficult to set up a tight face cycle, which is essential for maximum efficiency. Drills may be separate, each with its own cable, though a common practice is to plug drills into cutting machine takeoffs.

Flexible-shaft drills, likewise operating from cutter takeoffs, have made major strides in conveyor and other mining in recent years, as has the hydraulic hand-held drill powered either from the hydraulic system on the cutter or, if the cutter has no hydraulic facilities, from a special hydraulic portable pump.

Field Reports

High-Tonnage Punch Mining—Mines approximately 5,000 ft wide along outcrop and 7,200 ft deep, providing around 3,000,000 tons of coal, worked with track, section belts and loader-shuttle car units. Coal thickness is 42 in and 51 men on payroll, two shifts, account for 1,224 tons. *Coal Age*, January, 1959, p 104.

Efficiency in Thin Seam—Loader-shuttle car units, with air breaking average 16 cuts, or 445 tons, per shift with 11-man crews in 46-in coal. Section belts are preceded by portable grizzlies. Blocks are split on retreat. *Coal Age*, May, 1959, p 70.

Thick-Coal Mining—Specially designed equipment enables section crews to mine up to 1,500 tons per shift from 15- to 18-ft seam. *Coal Age*, July, 1959, p 72.

Multiple-Unit Feed—One entry-development unit and two room panel units (see Opening and Development section for plan) feed to belt-conveyor system converging at single car-loading station. *Coal Age*, September, 1959, p 100.

Continuous Transportation in Thin Coal—Using a conveyor team made up of bridge units, mobile bridge carrier, chain feeder and rope-frame units, low-type loaders in 36-in coal average 483 tons per shift in entry development with 8-man crews. Peak production has been 550 tons. *Coal Age*, April, 1960, p 72.

Thin-Seam Conveyor Mining Under Weak Roof—Two-stage development of 7-heading mains and 80-ft faces in room development and pillar extraction feature conveyor recovery in 32-in coal under bad top. *Coal Age*, April, 1960, p 136.

Other equipment frequently found in a conveyor setup includes specially designed rockdusters and bolting units.

SUPPLYING CONVEYOR UNIT—Supply-handling equipment includes wheeled dollies operating in pan lines, and small hand or powered winches to pull timber and other heavy materials up to the face. In cross-pitch rooms, a plank roadway on which a wheeled dolly runs may be built to deliver materials from a hoist in the slope or chute opening.

The false pan line is a simple and effective alternative in flat or mildly pitching coal. Until the halfway point of the place is reached, a false line is built alongside the regular line by pulling it forward and attaching a section each time the regular conveyor is extended. Each new false pan is loaded with enough supplies to take care of that much advance of the face, and the line is pulled up by the cutter so that the inby pan can be unloaded and added to the regular line. When the last section of the false line is pulled up, the room is completed.

Outby the rooms, supplies may be brought in by rail trucks, by rubber-tired equipment or by reversing the panel belt. Some belts have been fitted with jogging and inching controls for this purpose.

Scheduling Face Work

The usual face crew, whether loading by hand or power, is 3 to 4 men, with as high as 10 to 12 on extra long faces. Average output, in hand loading, is 1 to 3 cuts in the usual rooms. With self-loading equipment, production is increased to 2 to 4 cuts per shift—sometimes more.

Attaining production rates of this magnitude requires a careful study of crew size and operating cycle. Unless places are extra-wide or some special situation exists, the usual face crew, as noted, is 3 to 4 men. More than that number under normal conditions seems to result in interference and lost time.

The cycle itself is the critical factor in high productivity. For high efficiency, the various elements in the cycle—cutting, drilling, shooting, etc.—must overlap, and must be tightly scheduled to prevent waste motion and time loss. The basic goal is as little interruption in the flow of coal as possible. The best way of attaining it is through time study and the establishment of a fairly rigid system of standard times, plus a fairly exact schedule of when to do what.

Machine Mining

Take pillars to increase recovery and cut development cost. Consider the advantages of the flat pillar line.

Provide enough places so that coal is always available.

Keep haulage distances short. Consider the possibilities of bridge and extensible conveyors.

THE BASIC machine-mining unit, meaning here the unit based on a mobile loading machine, is made up of the loader itself, a cutter, a drill and, in most instances, one or two shuttle cars. Additional equipment may include a roof-bolting unit, a rock-dusting machine and a mobile supply truck.

A high degree of flexibility characterizes this unit, and thus it has been applied in practically all types of mining, including semilongwall, in both thick and thin coal and in both flat and lightly pitching seams. Number of working places per unit ranges from a low of two up to 20 or more. The average is 6 to 10. Crews range from 3 to 5 up to 20 to 25 men, with the most common around 8 to 12. Production per unit runs from as low as 100 tons up to as high as 1,500 tons per shift, with 300 to 600 tons as the majority. Tons per faceman ranges from 20 to nearly 100 in a few instances, with 30 to 50 perhaps the most common.

Machine Projections

Because of the flexibility of the load-unit previously noted, mining plans range from completely closed panels with no pillar extraction to what might be termed the wide-open system with all openings—entries, rooms and crosscuts—projected on the same centers. This latter, if followed completely, results in dividing the coal into blocks of uniform size, permitting both flexibility in attack and, at the same time, a standardization of extraction methods conducive to both high unit productivity and high tons per man.

LOW-ANGLE PILLAR LINES—Where pillars are removed with machine units, the tendency is to reduce the angle of the pillar

line from 45 deg sometimes down to zero or to a completely flat line. Two major advantages result. One is that the span supported on the projecting points or stumps is materially reduced in going from 45 to some smaller angle. On a flat line the span vanishes. And as the span is reduced, the weight of top in the angle requiring support is reduced accordingly. In one instance a change from 45 to 22½ deg, with a minor change in block centers, cut the weight to be supported to one-third of the total under the 45-deg plan previously employed.

Whether short lines or stepped lines are feasible is another question in projection. Each case must be studied individually but there are instances of successful operation with very short lines. Also, there are instances of steps of considerable magnitude in lines as a result of permitting entry recovery to lag behind to provide room for a tail track, as well as permitting one group of rooms operated by one mining unit to get considerably ahead of the next group. The conclusion therefore is that with most top there is considerable flexibility in establishing and operating pillar lines, though, other things being equal, a reasonably long straight line normally provides the maximum results with a minimum of trouble. And whatever the system, a cardinal rule is getting the coal out clean or making sure that any pillars or stumps that cannot be recovered are shot before they are left.

PLANNING WITH MODELS — To reach better answers to questions as what methods are best, at least one operating company has used table-top models. The elements in table-top modeling are blocks of the correct size to represent pillars; cardboard or other sheets to represent stoppings and brattice lines; wire or cord for cables, etc., plus miniatures to scale of the machines. When a problem, such as where to anchor shuttle-car cables, comes up, it can be solved by setting up a typical working section and experimenting to find the best spots. Cuts of coal can be added or subtracted by using small blocks and an entire pillar-recovery cycle can be run through as examples of other things that can be done.

The overall look afforded by the table-top model makes it easier to see all the elements of a problem and thus frequently points to the obvious solution immediately, saving time spent underground and on experiments that do not work out (*Coal Age*, August, 1957, p 74).

PREVENTING BUMPS—In brief and perhaps oversimplified terms, bumps are the result of a concentration of stress in the interior of a block or blocks of coal as a result of weight. As the weight builds up, the coal in the pillar is stressed more and more, until it suddenly fails in explosive or semiexplosive fashion.

Preventing weight buildup is a combination of a number of things as outlined in a more detailed discussion of bump prevention in the section on "Roof Control." Careful study will permit evolving a mining plan which will eliminate or reduce load buildup of the type which results in bumps.

In addition to mine layout, pillar design and pillaring system, bumps may be avoided by drilling or augering suspected pillars. In this process, the weight is unloaded gradually, or the bump is triggered while the weight concentration is small and before actual mining of the pillar starts. For a fuller description of the pioneer drilling and augering plan for bump control, see *Coal Age*, January, 1955, p 68.

Machine Plans

A key factor in efficient machine loading is coal and transportation at all times. An adequate coal supply requires, among other things, an adequate number of places in which to work. The basic rule is that as soon as the machine is finished in one place coal should be ready in the next for loading. Acceptance of this rule means that with conventional room haulage—usually the shuttle car—the minimum number of places usually is four, exclusive of crosscuts. In the past, however, some operators have approached the question from the standpoint of high tons per man from a small crew in two to three places. If tons per man are high enough, they compensate for the fact that fewer tons are secured per dollar of investment in machines. New equipment, on the other hand, removes this objection to a small number of working places. The bridge conveyor is an example, but even with it there should be enough places so that the loader never has to wait for coal.

SHUTTLE-CAR HAULAGE — Though there are many variations, the section layouts for shuttle-car haulage tend to be one or the other of two types:

1. The panel plan with rooms turned both ways and driven in groups of 5 to 7 or more. One reason for the use of this plan is the fact that pillars are not recovered. However, with modifications, pillaring can be done with this plan also.

2. The conventional block or room-and-pillar plan devised for pillar mining, either with short lines for each room section or longer lines advancing continuously from section to section. To facilitate the latter, some block plans, as noted in the Planbook elsewhere in this section, are set up with all openings on the same centers so that pillar lines can be established and advanced without having to shift gears when an entry is crossed.

In developing for both plans, the usual practice is to drive a minimum of 4 or 5 headings to make entry work as near like room work as feasible and thus as efficient as possible. Heading stations are established every 200 to 300 ft, at which distances the shuttle-car haul is kept under the generally accepted maximum of 500 to 550 ft. If track is used, it may be looped completely, or may be turned into a room or back down the next heading to establish a tail track for transfer from shuttle car to rail car.

With track setups, all shuttle cars normally must dump at the same point. Consequently one must occasionally wait on the other. Where panel belts are used instead of track, however, some operators restrict one shuttle car to dumping at the end and require the other to use a crosscut farther down to prevent interference and loss of time in waiting to use the same dumping point.

ANGLE CROSSCUTTING — Crosscuts may be angled each way from the center heading to facilitate higher-speed shuttle-car operation. This is especially true in operations based on mining individual panels, and particularly where pillars are left. In some plans, the angle crosscuts continue to become rooms, with angling continued in making room crosscuts. In a group of five or more rooms for example, the center usually becomes the key room, often leading directly to the car or belt-loading station. See accompanying Planbook for examples.

TOP BENCHING—Extra-thick coal offers some special problems in machine mining. At one mine, as an example, though the mining system went through a number of changes, all openings invariably were driven along the bottom. Top and rib deterioration and the onset of weight always outpaced the rate of extraction, thereby making it difficult to achieve the desired recovery. The cure was found in driving the openings in the top of the seam and bolting the roof, which permitted fast, economical removal of the lower portion of the pillars by loader or scraper (*Coal Age*, November, 1954, p 92).

TRACK HAULAGE—In loading directly into mine cars, maximum efficiency involves these steps:

1. As big a mine car as possible to reduce the number of changes per cut.

2. A one-way distance back to the closest changing point of not over 150 ft.

Prefabricated track provides a reliable means of attaining the second objective, as well as the further goal of track that can be installed, taken up and moved quickly and with a minimum of labor. Prefabricated track also forces adherence to the mining plan, which is helpful over both the short and long pulls.

CONVEYOR HAULAGE—Continuous availability is the major advantage of the conveyor as a haulage unit, but keeping the loader boom over the conveyor was a major difficulty in early installations. One solution was the bridge conveyor, followed by the extensible belt to reduce the stoppages for extension.

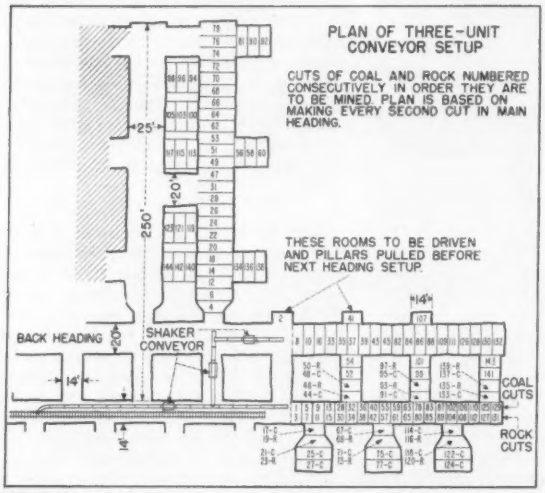
Early bridge-conveyor plans normally were based on two or three places per unit —sometimes four or five. Basic equipment in the unit was two to five room conveyors, two to five bridge conveyors, a cutter and drill in each place, and a crawler-mounted loader, plus mother or cross conveyor, elevator, car-spotting hoist, roof-bolter, rock-duster and so on. The loader moved from place to place, and a mounted cutter sometimes was substituted for the individual shortwalls, alternating with the loader.

In general a good top or one which lends itself to bolting facilitates the use of bridge conveyors by making it easy to establish the necessary travelways.

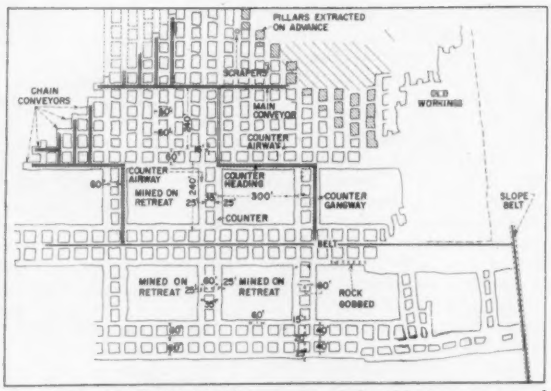
An early panel setup for bridge conveyors is shown in the Planbook in this section. Coal thickness is 26 to 36 in. The mining plan (*Coal Age*, April, 1957, p 60) is full

Mechanical-Mining Planbook

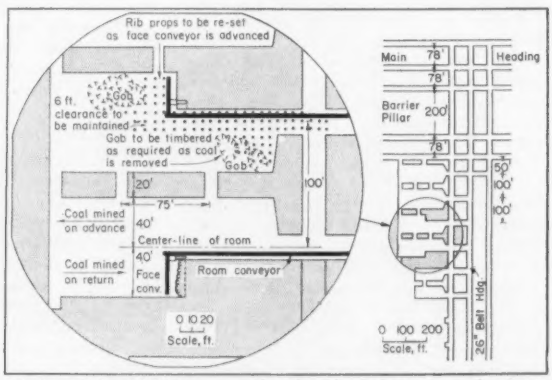
Conveyor Plans



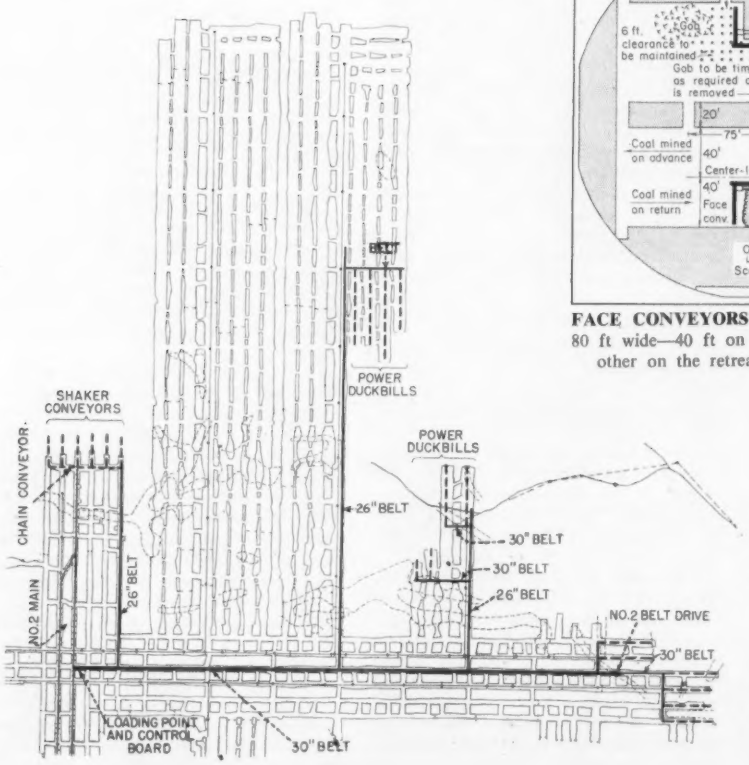
HEADING ADVANCE alternates with room work in this conveyor plan based on mining on one side on the advance and the other on the retreat. Rock is loaded every second cut in haulage headings, where necks are made extra deep.



CASCADE DEVELOPMENT up the pitch with two groups of conveyors plus scrapers for recovering pillars. Chutes and lowering conveyors bring the coal down to the main belt in the crosspitch gangway.

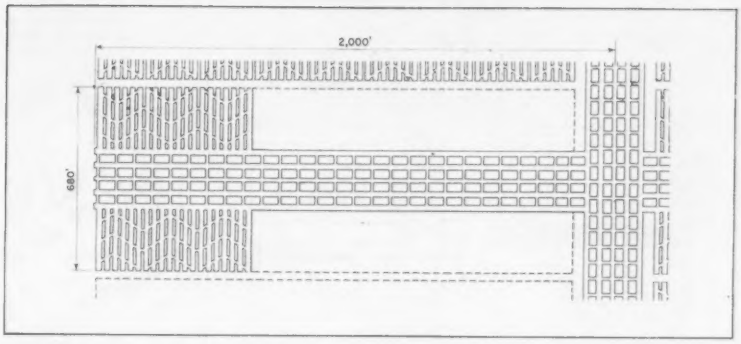


FACE CONVEYORS are employed with shakers to work places 80 ft wide—40 ft on one side on the advance and 40 ft on the other on the retreat. Coal thickness is 32 in with bad top.

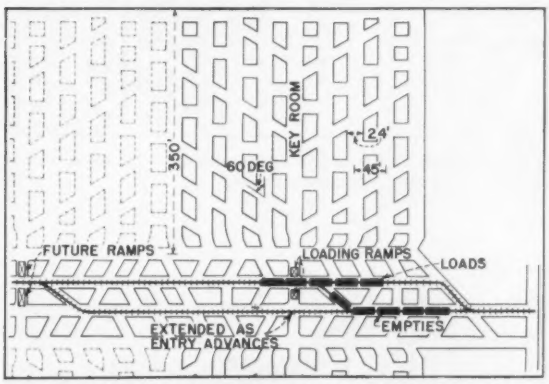


"CONTINUOUS-ROOM" PLAN for conveyor mining permits moving room units straight ahead a minimum distance by using mother and cross belts.

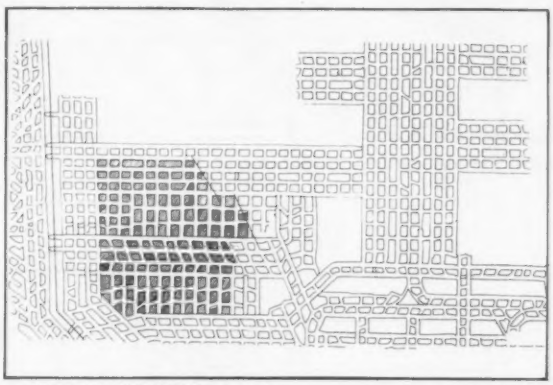
Machine Plans



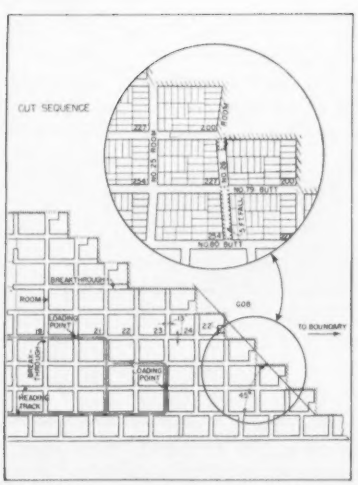
KEY-ROOM PLAN with shuttle-car haulage in thin coal. The center heading of the panel entry is brushed for track and mine cars. Rooms are worked in groups of five to seven, and the crosscuts are angled from the key room for easy shuttle-car travel.



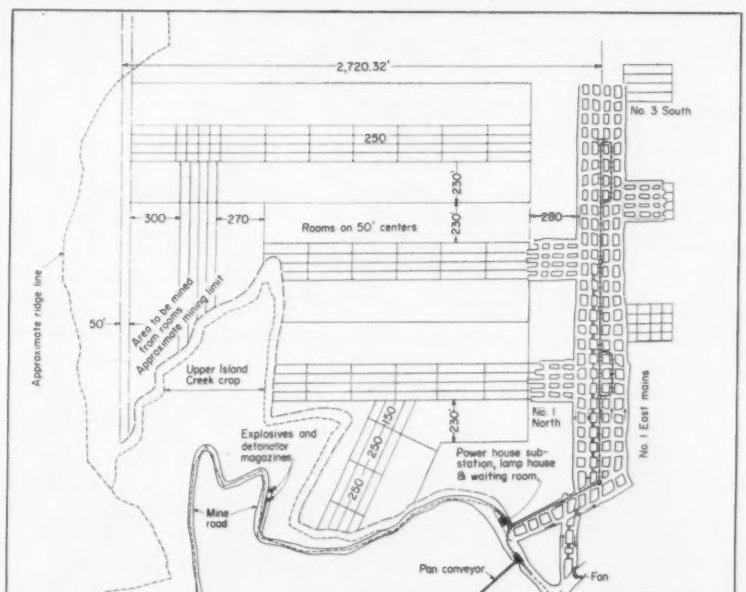
SHUTTLE-CAR PLAN showing double-tracking for mine-car loading, key rooms to loading ramps and angle crosscuts.



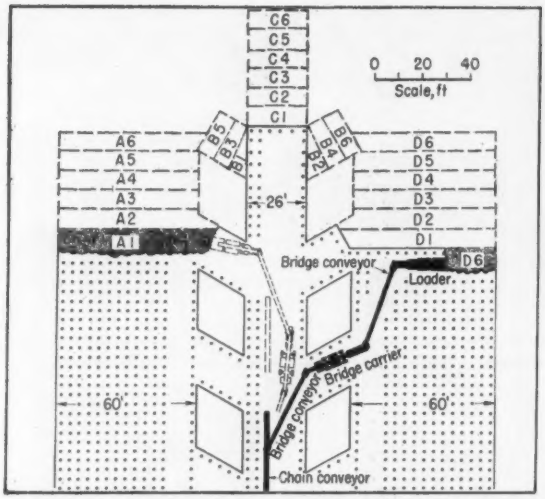
BLEEDER OPENINGS in this retreat plan for mobile loading machines are formed by leaving pillars along panel entry.

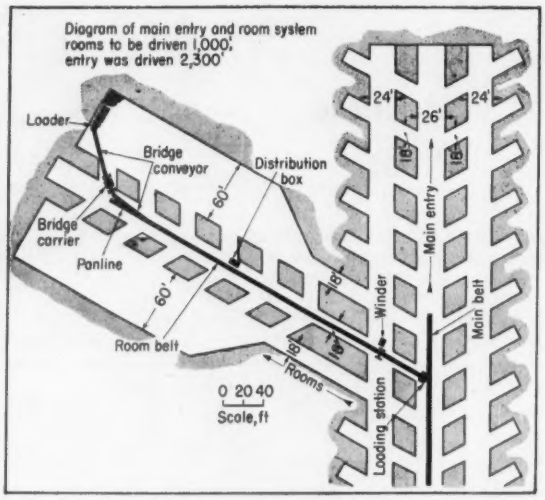


LOOP CIRCUITS simplify rail haulage and keep cars right-end-to in this block plan for shuttle cars. Pillars are open-ended in numbered sequence to provide close control of breakline. New places are developed only as necessary.

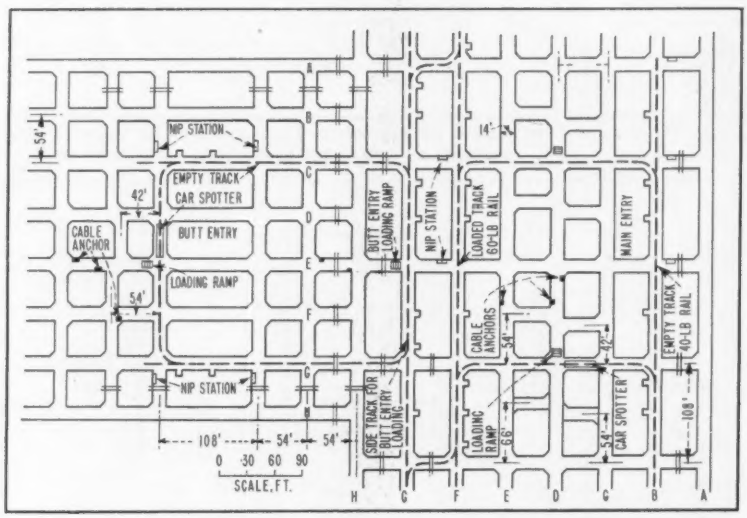


PUNCH MINING, usually on a smaller scale than shown here, involves small compact areas, usually with belts to the outside but with track on occasion. Advance on one side of panels and retreat on the other feature this setup for 3,000,000 tons.

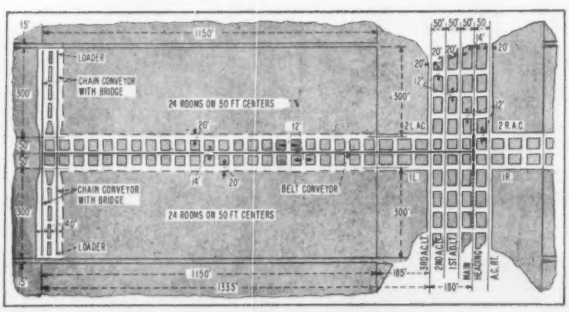




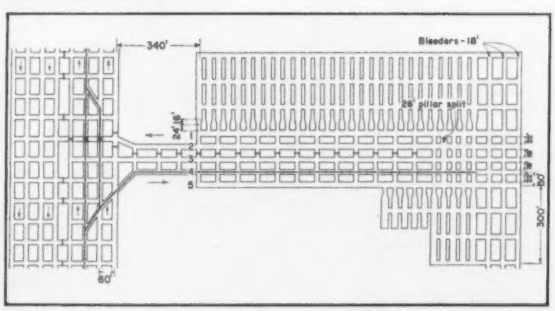
NEW BRIDGE AND BRIDGE-CARRIER EQUIPMENT, plus mobile and extensible conveyors are the key items in this room plan in thin coal. Advance from one crosscut to the next can be made without panning up.



ROOM WORK is eliminated in this plan to permit straightaway advance with eight headings and subsequent mining of entry pillars.

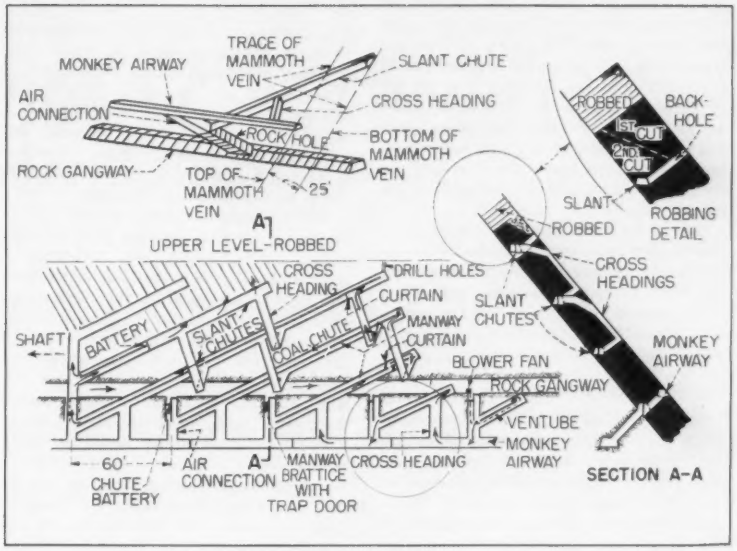


THIN-COAL PLAN is based on using bridge conveyors behind loaders in pairs of places on each side of panel entry. The panel entry (three headings) is first driven to the limit and then the rooms are moved on the retreat.

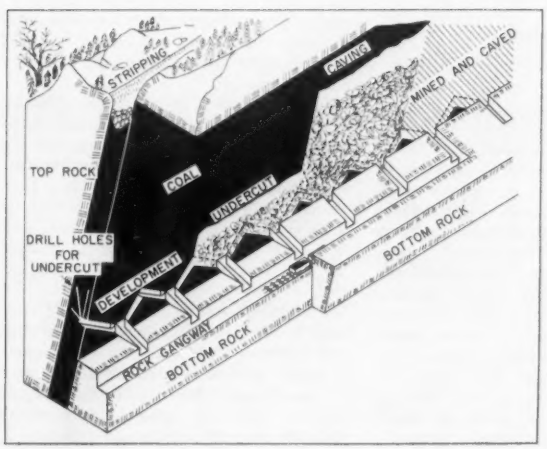


COMBINATION ADVANCE AND RETREAT PLAN keeps all work on fresh air. Places are normally driven in groups of five and pillars are left. Enlarged pillars at the top of the panel protect bleeder openings.

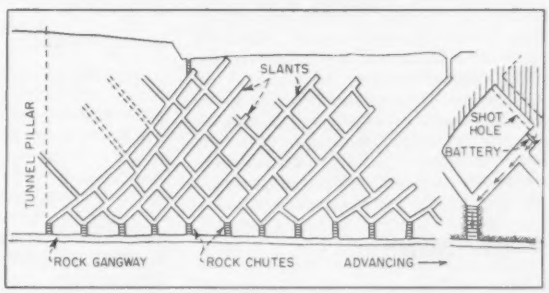
Pitch Plans

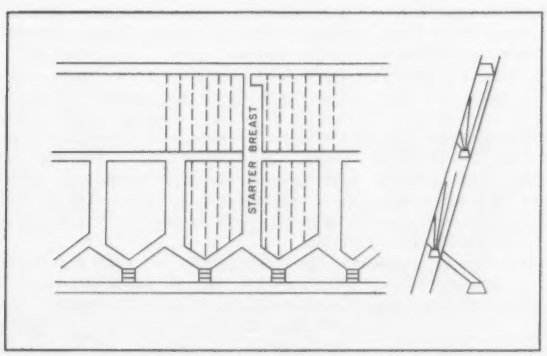


SLANT-CHUTE SYSTEMS (above and below) are examples of plans devised to reduce manual labor and raise efficiency in steep-pitch mining. In line with general practice today, gangways are driven in rock under coal.

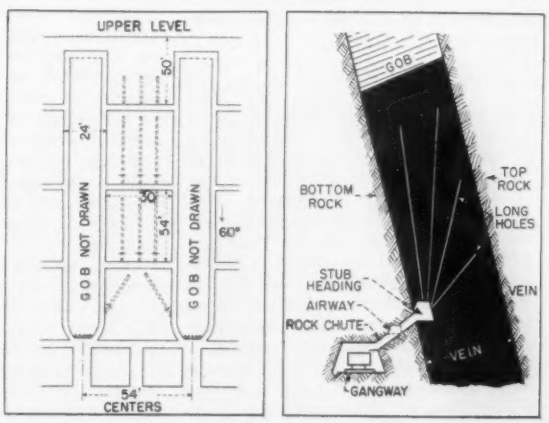


ORIGINAL INDUCED-CAVING CONCEPT for mining steep anthracite veins involving undercutting after development to start the caving.





LONGHOLE DEVELOPMENT PLANS include this version employing sub-breasts at intervals plus counters for removal of the coal in two lifts.



TWO LONGHOLE PLANS show (left) development along usual lines except that pillar size is increased to permit drilling and shooting, and (right) operating in nearly vertical vein with only drill headings in the coal.

retreat with pairs of rooms turned right and left off the panel entry. Panel haulage is by belt. Average output is 21 to 22 tons per faceman. A pair of rooms is completed in about five days. The conveyor lines are left in place and the mobile drive sections are trammed to the new sites with enough pans and the tail section to start the new rooms. Equipment moves take about 5 hr and are made on the third shift by six men from the regular crew.

One of the latest plans for loader-bridge conveyor mining (see accompanying diagram; also Development Planbook for entry plan) involves additional bridge and conveyor units with room belt for continuous loading and a minimum of lost time in moving.

Pillaring Plans

Loading machines can be used in practically any system of mining individual room pillars, including slabbing and splitting. The two most-used plans, however, are open-ending and pocket-and-stump. Examples of these and other plans are shown in the "Continuous Mining" section of this Deep Mining **Guidebook.**

A variation of open-ending is pocket-and-fender, under which the stump is cut down to a shell only 2 to 3 ft thick. A subvariation is gripping the cutting machine out each time to make a saw-toothed fender and increase recovery slightly. Timbering plans for pillar mining are discussed in the "Roof Support" section.

In open-ending, it usually is best to arrange the direction of advance so that the machine operator is on the side away from the coal and protected from sloughing and rib bursts, particularly when heavy weight is the rule and the coal is soft.

Pitch Mining

Use self-loading conveyors or scrapers, standard loading machines or continuous miners on light pitches. The latter normally provides highest tons per man where conditions permit use.

Use longhole methods in heavy pitch; as an alternative, use a slant-chute system. Consider the possibilities of induced caving. Bore crosscuts to save labor and cut stoppings cost.

Light Pitch

Practically any type of equipment may be used at the face of places driven either up or down light pitches (normally 5 to 18 deg). Usually, however, some form of conveyor is necessary for transportation. With this limitation, all the ordinary panel plans, with or without pillaring, and practically all the conventional face equipment may, as noted, be employed. Usually, particularly as the pitch increases, the practice is to put headings up, down or both—usually up—and rooms across the pitch. Among other things, this permits the use of shuttle cars on pitches up to 10 to 12 deg or perhaps slightly more, the cars discharging to either a lowering or hoisting conveyor relaying the coal to the main-haulage system. Angle crosscuts between places permit easier movement of units from place to place in conventional machine loading.

Moderate Pitch

Galvanized iron kept wet provides perhaps the flattest gradient on which coal will flow of its own accord. The minimum is around 20 deg. At about 25 deg, coal will begin to flow on ordinary iron and, at something around 35 deg, on wood. Below approximately 20 to 22 deg, therefore, it normally is necessary to install conveyors to move coal down the pitch.

Where pitches of this degree prevail, customary practice is to sink belt or rope slopes, turn gangways right or left on a grade rising slightly to facilitate water flow, and then work rooms up the pitch, using hand labor to get the coal to the conveyor or chute. Modifications, however, include a few plans for crosspitch room work. One involves driving a pair of rooms up a 40-deg pitch and installing in one a timber track with hoist, a ladder and a chute. Rooms are turned 90 deg across the pitch, and a shaker is installed along the lower rib of each one. Cutting machines may be used at less than the maximum inclinations, and the machine rope may be used to pull a side-loading pan on a shaking conveyor uphill along the face to speed leveling. Pillars may be removed by open-ending, with the coal running down to the pan line. In some instances the open end may be angled toward the mouth of the place.

Heavy Pitch

Attempts to eliminate the high percentage of hand labor necessary in steeply pitching seams have included plans which would cut down the pitch of openings in which men had to work to that on which coal would run on either iron or the natural rock, meaning to a minimum of 35 to 45 deg. The "lattice," "diamond," "slant-chute" and other similar plans differ largely in details—for example, 30-deg openings with sheet iron and without batteries in one "diamond" plan, compared to 45-deg openings, no sheet iron and batteries at intervals in one "slant-chute" system. In both, the openings are first developed to the old gangway above and the pillars are recovered on the retreat back down.

Usually, one-third to half of the pillar is drilled with holes up to 45 to 50 ft, loaded with explosive laced with detonating fuse to insure complete detonation, and shot. The coal then flows to cars in the gangway, controlled as necessary by checks or batteries. In the slant-chute system a new battery normally is built immediately below each time a new section of pillar is shot.

Because life usually is long and disturbance in the vein can be substantial after mining gets well started, the trend is toward gangways in the rock under the vein, with rock chutes up to the coal. This leaves a strip of coal between the rock gangway level and the top of the rock holes. This strip may be recovered from the next gangway below, or short, level rock-holes can be driven to the vein, which then is opened up by chutes as necessary and then drilled and shot into short conveyors leading back to the rock gangway.

INDUCED CAVING—Another proposal for reducing labor in mining heavily pitching veins is "induced caving." The original idea, as developed by the Bureau of Mines, is shown in the accompanying illustration. It involves a gangway in the rock under the vein, rock holes up to the coal, slant chutes between rock holes in the vein, and undercutting of a section of the vein by drilling and shooting to induce caving.

Longholing

Longholing—a fairly recent development—materially reduces the labor required in the preliminaries to production. Variations in longholding methods largely reflect how much preliminary development work is done. As an example, in moderate pitches the conventional chambers and crosscuts may still be driven, the principal change being an increase in the size of the pillar left. The pillars then are drilled and shot instead of being mined in the ordinary way. Holes therefore are seldom more than 50 ft long. An example of plans where the emphasis is more on drilling of pillars formed along conventional lines is shown in the accompanying illustration.

Longholing with minimum development at one operation is based on gangways and airways in the rock beneath the vein, with rock-holes to the vein at intervals fitted with batteries to control coal drawoff. Holes drilled back from the next rockhole and cased with pipe insure positive ventilation behind the battery both before and after shooting. Holes also are drilled to the next level above to drain off any water that may have accumulated.

Longhole drilling is done from a heading in the coal. To start a section, two places are driven up to the old workings and the chain pillars are removed to provide expansion room for the coal to be shot. Then the coal between two rock holes is shot by three groups of three holes each, one parallel to the bottom, one angling up through the vein and one directly toward the top rock. Firing is on off-shifts or idle days.

Longholing with a little more development in the form of sub-breasts at intervals and counters for drilling the upper block is shown in another illustration. For starting, one breast is developed up to the upper gangway. After the upper block is drilled the lower is removed in similar fashion.

The capital investment required for longhole drilling is relatively small and productivity at the face is increased 50% or more.

Boring Crosscuts

One of the more aggravating and expensive items in gangway development in coal in moderate to heavy pitch mining is crosscutting between gangway and airway. The big drill is one answer. Size may range from 24 to 42 in, and one, two or three holes may be drilled up the pitch to get the required crosscut area. In contrast to an earlier version (*Coal Age*, May, 1951, p 100) a new and much-lighter type (*Coal Age*, August, 1955, p. 58) employs a hoist and rope to pull the big bit through a pilot hole.

The underground auger (illustrated in section on Opening and Development) is a new possibility in making crosscuts, and also may be used for production by drilling up the pitch.

Another advantage of the bored crosscut is that a simple disk rather than an expensive custom-made stopping can be used to close it.

Face Preparation For High Loader Output

Prime Objectives

An ample supply of well-prepared coal for loading at all times.
Conduct of face preparation itself at minimum cost.

Key Approaches

Careful study of bits, bar length and cutting pattern for maximum effectiveness.

Selection of drill types, bits, augers and hole patterns for most-efficient breaking.

Choice of shooting or breaking mediums providing the desired results in size consist and loadability.

Practice Trends

More delay breaking with either delay detonators or sequence air breakers.

Increased use of mobile equipment, including rubber-tired drills, for more tons per crewman.

Bits

Use types that cut the most in tons per dollar of cost.

Keep bits sharp for faster cutting, lower power consumption, less wear and tear on the machine, and a better size realization.

Adopt measures to prevent breakage and loss of bits.

CARBIDE-INSERT bits for either cutting or drilling normally are well worth their cost. A wide variety of designs are available and thus it is easy to match bits to coal and mining characteristics—and to change when characteristics change. Under some conditions, however, plain quenched bits may be quite satisfactory, with alloy and tipped types filling the gap between carbon and carbide.

PREVENTING LOSS—It is highly desirable to keep all possible metal out of coal, which is one reason for care in preventing bit loss or careless discard. Another is bit cost, particularly the carbide type. The rule, therefore, should be an old bit or a thorough accounting before a new bit is issued. Establishment of fixed quantities in the hands of each operator or crew, supplemented by regular inventory, helps keep down losses.

Protection against damage or loss is enhanced by such steps as locked cabinets, and special bit boxes and holders for carrying and storing bits. See accompanying illustration for examples.

BIT MAINTENANCE—Though there are times in coal mining when the bits just have to take it, one secret of long life and low cost is care in use, including care to remove bits for reconditioning before excessive dullness results in damage, in addition to slowing down the cutting and drilling rate.

Grinding methods can materially affect the cutting qualities of carbide-insert bits, and also the total number of regrinds possible, in turn affecting service life. Manufacturers' recommendations should be the guide. For a step-by-step illustrated description of grinding and reconditioning both cutter and drill bits, see *Coal Age*, July, 1957, p 71.

Cutting

Use long bars, other things being equal, to reduce number of loader moves.

Consider universal machines for greater flexibility in cut positioning and because they make it possible to shear when desirable.

HIGH CAPACITY and greater ease in moving are the major reasons for the increasing use of rubber-mounted cutters, now available for coal as low as 36 in or less. Below that, the shortwall is about the only answer, as well as in coal pitching more than about 10 to 12 deg.

Special equipment for small mines in very thin coal include a shortwall with four rubber-tired wheels which are raised by jacks for cutting and then lowered for tramming.

Hydraulic and other modern controls make the modern shortwall a more-versatile and higher-capacity unit. Bug-dusters can materially reduce labor and normally make it unnecessary to clean the kerf. Otherwise, kerfs should be cleared of cuttings to promote safety in shooting, reduce powder consumption, prevent "hung" cut and generally improve loadability. However, certain newly-developed cutting systems, notably the "three-pass" summarized later in this section, reduce or eliminate the need for bugdusting facilities or labor.

Long bars are a distinct advantage in machine loading, since the more tons per fall the fewer the time-wasting moves the loader has to make. Cutting with a long bar, how-

Field Reports

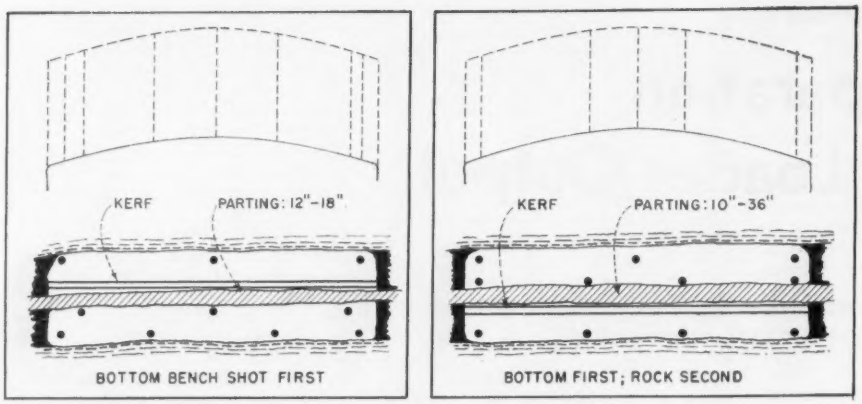
Thin-Coal Cutter—Designed for "truck-mine" service in coal as low as 24 in, new shortwall-type cutter is equipped with wheels and jacks for raising for cutting and lowering for tramming. *Coal Age*, June, 1959, p 90.

Multiple Shooting With Air—Sequencing system with shell-carrying truck permits loading four holes at a time and their discharge with one operation of the blowdown valve. Automatic discharge heads on shells eliminate shearing disks. *Coal Age*, January, 1960, p 78.

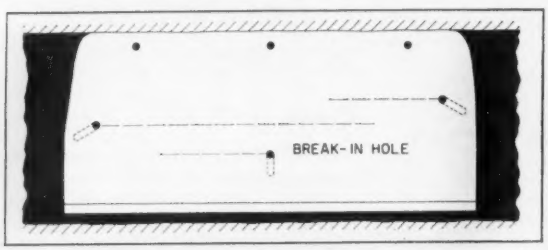
Thick-Seam Techniques—Use of millisecond-delay caps to provide time-saving and other advantages of multiple shooting feature operations in 10- to 18-ft-thick coal. *Coal Age*, May, 1960, p 114.

Where to Find It . . .

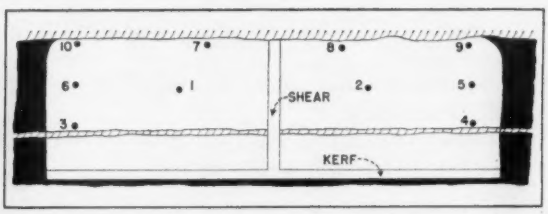
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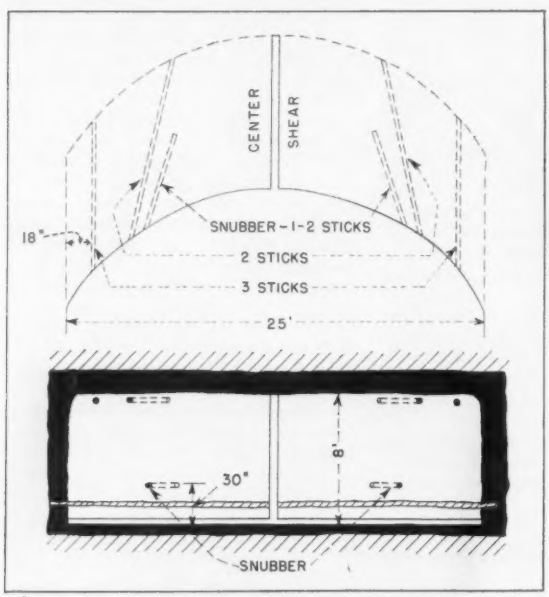
SHOOTING WITH HEAVY PARTINGS. Plan at left shows cutting above the parting, followed by shooting of the bottom bench first. Plan at right, for still-thicker parting, shows cutting underneath the rock and holes immediately above.



BREAK-IN-HOLE provides additional free face for relieving succeeding holes. In this plan, rib holes are stepped up to break lower part of face in section.



SHORT SNUBBERS break band and roll out front of fall in arc-cut center-sheared place. Shearing and snubbing reduce the number of holes required and also cut explosive requirements.



EQUALIZED BURDEN is the goal in this drilling pattern in a center-sheared place, thus achieving good breakage of both coal and impurity band.

ever, requires greater operator skill and increases the risk of striking undulations in the bottom and top, as well as the risks of fouling and binding. If they replace shorter bars on existing machine, care should be taken to make sure that the motor can carry the extra load, either as is or with improved insulation.

Cut Positioning

Simplicity, ease and custom are behind the preponderance of undercutting, which has the further slight advantage that the fall helps to break up the coal. However, it normally necessitates shooting against the top and thus, where this results in serious deterioration, has led to top cutting. Cutting at other horizons may be done to get into softer zones, but usually is adopted to remove bone or rash. Where the latter is the goal, two or three cuts may be taken—or one regular cut may provide enough loosening and relief so that most of the remaining material can be raked out.

BENCH MINING—Cutting under a middle parting in thicker coal may be done as one step in bench mining, the lower bench being shot up and loaded, followed by dropping and disposing of the parting, and shooting and loading of the top bench. Very infrequently, cutting may be done in rash or soft clay under the seam, or in soft material above, either to keep the kerf out of the coal or to eliminate hazardous or troublesome top material. However, such selective mining is on the decrease and the trend today is toward full-seam extraction, including, in some instances, top stone or drawslate. This system relies on mechanical cleaning on the surface for removal of the impurities, since it normally results in a lower overall cost.

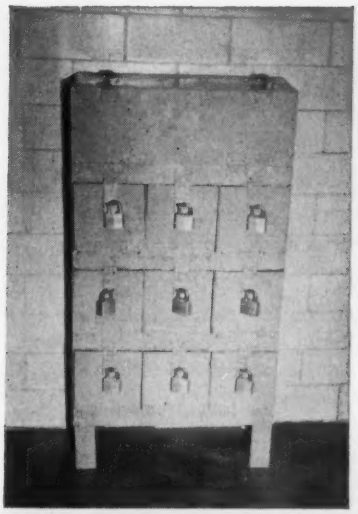
Special goals in cutting include raising the undercut where the bottom is soft to provide a good coal pavement for the operation of shuttle cars and other equipment.

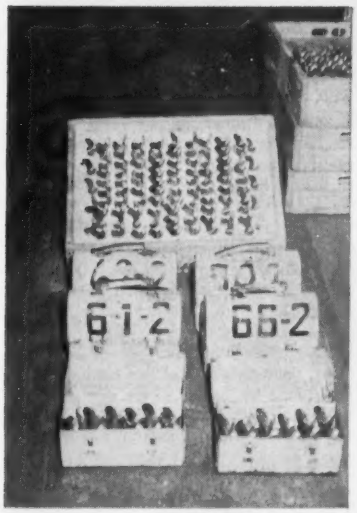
Multiple-Pass Cutting

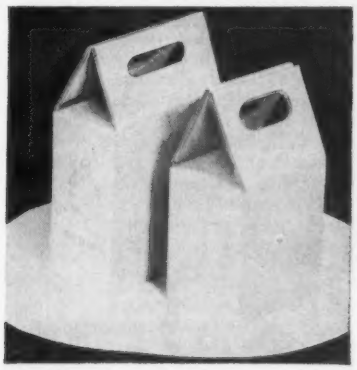
Under some circumstances, making more rather than fewer cuts may be an advantage. A three-pass system developed by one company is shown in an accompanying illustration. Benefits include a substantial increase in tons per cut, reduced loading time, lower power consumption and less wracking of the cutter. Obviously, cutter capacity should be great enough to permit the extra passes without falling behind the loader.

Shearing

The vertical cut, or shear, provides an additional free face, or faces, and is highly valued by many operators as a means of reducing explosive consumption, raising coarse-coal yield and increasing loadability, even though it does result in more bugdust.



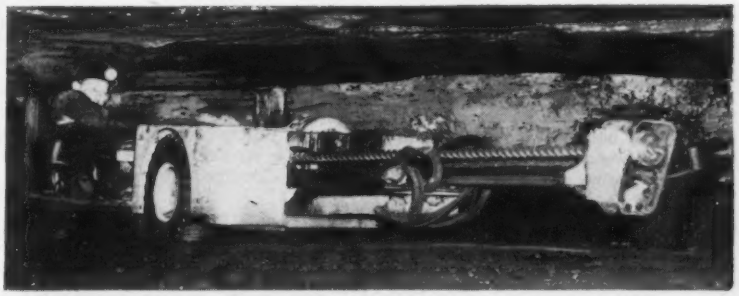




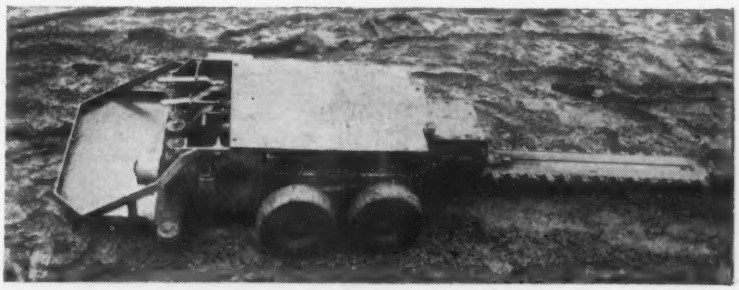
PROTECTION AGAINST DAMAGE OR LOSS is especially necessary with modern cutting and drilling bits. Top photo shows locked cabinet for preventing loss and mishandling. Cabinet has compartment for each section's supply. Middle photo shows wooden bit holders in lunch boxes carrying section numbers for easy handling. At bottom are corrugated-fiber boxes—one of the newer ideas for carrying and storing bits.



MULTIPLE-HOLE AIR BREAKING involves rubber-tired truck for transporting tubes. The truck also is equipped with a sequencing valve for discharging tubes automatically after tripping by the operator.



HIGH-SPEED HYDRAULIC DRILL with self-propelling drive fits in with fast-moving loading and preparation cycle.



"TRUCK-MINE" SHORTWALL for coal as thin as 24 in has wheels with jacks for raising for cutting and lowering for tramming.

In permanent headings, some operators have sheared booth ribs to keep them free from shooting shock and thus postpone and reduce falls and sloughing.

Since shearing takes time and, as noted, increases the output of cuttings, shear cuts normally are limited to one—usually at the side in headings or other narrow openings, and between one-third over and the center in rooms.

Drilling

Match drill to the job; choose auxiliaries, such as augers, on the basis of performance.

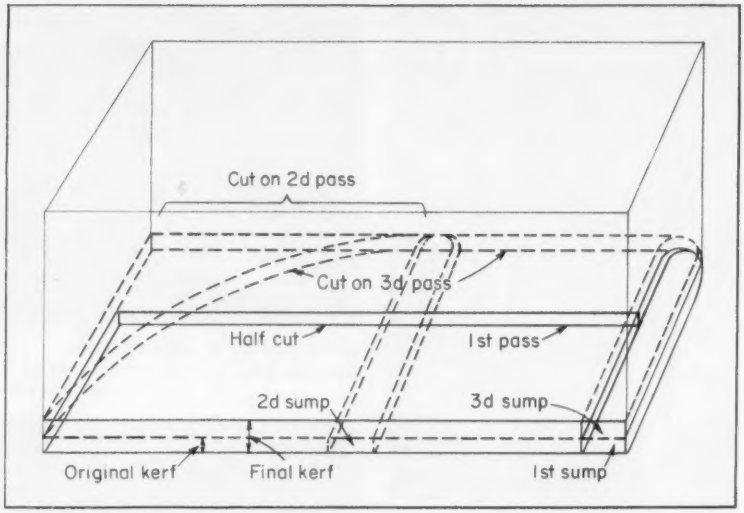
DEPENDING UPON CONDITIONS and personal preference, operators have a wide choice in drilling equipment, including not only pneumatic equipment but also hand-held, postmounted and mobile units. The latter may be designed with one or two arms, with the hydraulic auger drive now coming to the front for greater capacity and flexibility. Hydraulic drill positioning frequently can release one man from the crew for other productive work.

Hand-held units driven either by flexible shafts or hydraulic motors are a relatively recent addition to the types of drilling machines available and in some instances have successfully challenged even large mounted units. Light weight, high speed and operation from the cutting machine through either a mechanical or hydraulic takeoff are among the secrets of the machines' success. Where the cutters do not have a hydraulic system, certain operators have found the drill benefits sufficiently large to warrant installation of a special portable hydraulic power unit.

AUGERS—The "conveyor" auger or approximations thereof now has taken over to a considerable extent from the old twisted auger in coal drilling. Advantages include



SAFETY ACCESSORIES include galvanometer to test circuits in millisecond delay shooting—a growing practice for promoting both safety and efficiency



THREE-PASS CUTTING PLAN involves, first, sumping in at right, pulling out halfway and then cutting to left rib; second, sumping in center and cutting to left; and, third, sumping at right immediately over old kerf with bar tilted down toward back, cutting to center and then tailing out at left side. Third cut also cleans the kerf.

greater rigidity, with consequently less whip, and more resistance to bending. These features are especially valuable with hand-held flexible-shaft or hydraulic drills, where whipping or a bent auger is especially noticeable. Better hole cleaning also is an advantage, particularly where large holes are necessary.

Better cleaning of wet down-pitching holes may be attained by changes in scroll-pitch—usually an increase.

Shooting

Choose breaking medium carefully to fit conditions and give the size consist desired.

Study the job carefully to get the best hole pattern.

Stem carefully.

A WIDE RANGE of explosives and several breaking devices are available for the operator's choice in coal breaking. The breaking devices include carbondioxide, air and chemicals, all basically relying on building up pressure in a tube against a valve or disk which ruptures at a certain limit to release the gas or air and break the coal. Air is the most-used nonexplosive breaking medium, and the practice for some time has been to supply it from central stations on the surface, sometimes supplemented by large portable or semiportable units underground at strategic points throughout the mine.

Breaking with air recently has been facilitated by the development of sequence-discharge equipment permitting the loading of several holes at one time. The tubes are carried on a rubber-tired truck, which also is equipped with a sequencing valve. After placing up to six or so tubes in the holes the operator retires and trips the sequencing valve, which discharges the tubes at intervals of 12 to 15 sec. Normally, all holes in a single row are shot in one group, starting at the bottom. At one property use of the multiple-hole unit permits drilling and breaking up to 450 3-in holes per shift.

As a rule, carbon-dioxide, air and chemical breaking require a greater number of holes because the maximum force is less, though some operators get by with no increase and many with only a small rise in number. Any increase or other extra expense normally is more than offset by an increase in coarse-coal yield, or by other benefits, including ability to break coal on shift where all other shooting or breaking is forbidden by law or regulation.

To get the effect of a slower action with powder, some form of "cushion shooting" may be employed if other conditions are favorable. The air space around the charge may be secured by increasing the size of the hole or by placing the charge or stemming to leave an air space ahead or behind. Caution must be exercised to see that cartridges are not separated, thus setting up conditions favoring possible misfires.

Hole Placement

Shooting patterns are almost as numerous as coal mines. Normally, the best pattern for any mine can be determined only by careful study and considerable experimentation. One basic principle is that each hole should "relieve" the next. A second is that the burden on each hole should be adjusted to the maximum charge that can be loaded, though this maximum does not have to be the legal maximum. Consequently a common pattern is a row of holes in the top in thin coal, or in the top and middle in thicker coal, with the center hole shot first in the bottom row in two-row faces, and in the top row in one-row faces.

Modifications are numerous. One, as an example, is a row of holes immediately over a slate parting low in the seam to smash it and relieve the regular holes. Another is the snub shot, which may be a full-length hole in or close to the center to knock down the lower part of the cut and open up the face for the subsequent holes. As a variation, the snub hole may be drilled only part way in to break down and roll out the front of the cut. Bottom and snubbing holes may be angled down to get better breakage at the back and more force to kick the coal to the front.

Concentration may be sought for or avoided. As an example, the benefits of drilling a smaller hole may be more than offset by the stringing out resulting from use of smaller cartridges, thus preventing sufficient concentration of force to break the coal properly and economically. On the other hand, concentrating the force at the back of a deep cut in thin coal may result in the charge breaking down to the kerf in the back and leaving the front standing. One remedy is a slower-acting medium in more of the hole.

Charging and Firing

Stemming always is used with conventional explosives, but normally not with steel-tube blasting devices. However, instead of stemming, safety regulations in some regions require setting safety barriers or deflectors against each hole or the entire face to eliminate flying tubes. In lieu of conventional stemming, blasting plugs may be employed with explosives to save time. Conventional stemming includes the plastic clay dummy made by extrusion and available from extrusion specialists operating in many areas.

Single-shot firing with electric detonators still is the predominant system in the coal mines. However, it has definite disadvantages, one of which is the fact that the shotfirer is constantly exposed to the hazards of loose roof and must work in considerable smoke and dust in connecting to each charge after the first. As a result, there has been a substantial increase in millisecond delay ignition of shots in sequence. There is equal safety in relation to gas and dust, less chance of overbreaking exposing the following charges, less shock to the roof, and much less exposure hazard for the shotfirer.

Effective Roof Control At Minimum Cost

Basic Considerations

Protection of men and equipment from falls, crushes, bumps and other top, face and rib failures.

Keeping working places, including entries, open for the desired length of time, whether hours or years.

Achieving the collateral goals of no interruption of, or handicap to, haulage, travel, ventilation or other openings as a result of roof action—at a minimum cost for support.

Logical Follow-Through

Know what is involved in roof action.

Study roof at the mine carefully, especially the possible variations, as means of selecting the proper support system or systems.

Adopt standards for minimum support and insist on its being increased if there is any indication that it is necessary.

Mechanize the timbering operation to the maximum extent possible for economy.

Salvage supports to the degree consonant with safety to cut down the cost of support materials.

Practice Trends

Improvement in anchorage practices and equipment in bolting.

Emphasis on testing and indicators to measure bolting effectiveness.

Growing use of yielding arches and props.

Future Possibilities

Wider use of roof shields at the face.

Cementation of roof layers as a substitute for bolting.

ROOF SUPPORT is almost always required in coal mining either to protect main openings for the life of the mine or production places from falls that would endanger life and equipment and hamper production. This results from the fact that as openings are made in coal removal, the equilibrium of stresses is upset. The unsupported weight of the top results in a tendency to sag. This sagging continues until failure occurs unless (a) support is provided to prevent such failure or (b) the strength of the rock is such that it can support itself after the sag reaches a certain point.

Support varies with the objective, and also with the character of the material over the coal. For example, temporary protection against drawslate will require one type of support, while another type will be more suitable where both the drawslate and all the overlying material must be held. Still others will be better suited to permanent openings in bad top or caved ground. Weathering as a result of changes in temperature and moisture content of the ventilating air may warrant sealing the top, which is "support" in another guise.

In no instance, however, is it contemplated that the support provided by the original coal bed be replaced by support that will keep the roof in its original place and state after all the coal to be mined is removed. Even "permanent" support means only support until mining is completed. Between the time the coal is first opened up and the final pillars are removed, therefore, a number of roof conditions and roof actions may be encountered—some at every mine and all at some mines.

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Permanent supports . . . Temporary timbering . . . Timber economics

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Bolt types . . . Bolting patterns . . . Designing bolting systems . . . Bolt installation . . . Bolt recovery

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Coatings and their application . . . Injection bonding

Timbering

Match type of support to the specific job, whether permanent or temporary.

Study timber types and support methods to get the most economical support possible in relation to conditions.

TYPES OF SUPPORT in the "timber" classification range all the way from roof jacks at the face to steel, concrete and brick linings in permanent openings. Between these limits, timber includes posts, legs and bars of wood, steel and aluminum; yielding arches and rings of reinforced concrete and steel; concrete, brick and masonry columns, piers and abutments; such supplementary items as wedges, capboards, headers and lagging; and coal itself. Other forms of support, in addition to timbering, are bolting, and coating, sealing and bonding discussed later in this section.

Permanent Timbering

The goal in permanent timbering should be "permanence," meaning that life of the support, within economic limits, should match the expected life of the opening. This is not an absolute rule, however. In ground where movement can be expected for some time until the measures stabilize (longwalling, or driving gangways through previously worked ground, for example), it may be desirable to make the initial timbering job a temporary one, replacing it with final permanent timber when things have settled down.

As an example of "permanence" which is not permanent, consider the case of untreated wood with a life of around 3 yr in a haulage heading with a life of 10 yr. Since treated wood normally will last at least 10 yr, it could be considered "permanent," whereas with untreated wood the initial installation would have to be replaced at least once and probably twice, with each replacement normally more expensive than the original. The moral is that within limits it is better to spend more at the start for permanence, not only to eliminate replacement, and also production stoppages as a result of falls, but to keep routine maintenance as low as possible.

Conversely, of course, timber or support life can be excessive—and thus excessively costly—in relation to life of opening. As an

extreme example, it would be wasting money to line a 5-yr-life opening with reinforced concrete, though a sand-cement mixture an inch thick on wire might well be the thing for this particular application.

LINING—Support by complete lining is limited to rather special situations in mining. These include: soft sections of top near the outcrop in a permanent drift opening, or other soft or broken areas, as under stream valleys; and permanent long-lived openings on shaft or slope bottoms. Reinforced concrete is the old reliable in heavy-duty linings, and also provides complete sealing. Sealing with some support is provided by sprayed-on sand-cement mixtures, though support is only nominal when, say, the coating is only ¼ to ½ in thick. When applied over wire and in thicknesses up to 1 or 2 in, they provide some holding power in addition to sealing. When used with bolts, support also is realized in addition to sealing. Steel liner plates also provide ceiling with a considerable degree of support, and are low in cost and easy to install, using a concrete footwall as a starting point.

GROUTING—Though not strictly lining or coating, grouting has been used to strengthen top in sections of permanent openings under, for example, stream beds where the overburden is thin and the top is rotten. Elimination of water seepage may be a secondary goal. Sometimes it is the major one, with strengthening of the top as a collateral benefit of the grouting operation.

PIERS AND ABUTMENTS—Supports of these types usually are found at pillar points where openings fork, and at other places where considerable resistance to roof movement is necessary. They may be built of concrete, with or without reinforcement, concrete or cinder blocks, brick or masonry.

YIELDING ARCHES AND RINGS—Where weight is substantial, the top is badly broken, and there is a possibility of movement of the ground in which the opening is made, yielding arches or rings may be installed. Some types employ concrete blocks put together on the keystone arch principle. Of the steel types, the latest is the full-round with joints that slip and thus permit diameter to decrease without deformation until equilibrium is re-established.

THREE-PIECE SETS—Probably the widest used of all forms of permanent timbering, the three-piece set—a cross-bar supported on legs at each end—may range from a simple affair put together at the site up to a preframed and largely standardized set designed for heavy duty. Wood is the commonest material. As noted previously, it should be treated where life of opening is expected to exceed about 3 yr. The set also may be made of steel or may consist of wood legs and a steel bar where extra stiffness and resistance to bending are desired. If steel legs are used they should be set on concrete piers or low footwalls for maximum stability, especially in longer-lived places.

Wood is easy to obtain and work, and the three-piece set is both flexible and adaptable. Also, it supplies the required degree of support except under exceptional conditions, in which case special concrete or timber arches are about the only answers. Legs, however, reduce clearance and can be knocked out to cause, in many instances, severe falls, aside from the fact that they themselves represent an expense.

Two-piece sets are an alternative to three-piece under certain conditions—for example in a water-level gangway in pitching coal where one end of the bar is hitched into coal or rock and the other is held on a leg.

HITCH TIMBERING—To eliminate the leg and its hazards, bars may be installed in hitches either cut or drilled in the rib. Hitch holes may be provided for each individual bar. As an alternative, holes may be drilled some distance apart to accommodate pins. Steel bars are then laid on these pins and the regualr bars are placed on these stringers. Properly done, hitch timbering is permanent, especially if treated wood or steel bars are employed, and cost of installation (labor and materials) is much less than installation of a regular three-piece set. Routine maintenance and cleanup are cut to a minimum.

LAGGING—Spalling of top and sloughing of ribs are the reasons for the installation of lagging, which may be small natural round timber or sawed material. In long-lived openings lagging, like main timbers, should be treated. Lagging also provides some support, but its major function is holding loose roof material in place.

SINGLE POSTS—These have a wide use in permanent support, especially in openings where the spacing can be cut down, as in airways, manways and belt headings, or where the roof needs some support but a span of, say, car width can be tolerated. Short headers may be used to increase holding spread in tender top. As with bars and lagging, permanent posts, together with wedges and headers, should be treated.

COAL—Coal itself is widely used as a means of protecting and supporting top, though the support is chancy and not too great from the standpoint of resistance to weight. Sealing of the regular top is perhaps coal's major contribution.

Temporary Timbering

Temporary support naturally finds its widest application in the active working areas, including the working face, the room and the room entries. The major objectives are perhaps three:

1. Protecting men. The average dimensions of roof falls resulting in fatalities is given by the Bureau of Mines as: length, 13 ft; width, 11 ft; thickness, 2 ft. The majority of these falls (75%) occur in the face area in by the last permanent support, and 95%, says the bureau, are a result of human failure, meaning in turn primarily failure to install proper support.

2. Keeping workings open. The aim here is to preserve access to the face area from which production comes.

3. Holding top during pillar removal. Here, the support should have sufficient strength not only to hold the place open as long as necessary, but also to break the top at the desired point and thus help initiate the caving process.

STANDARD PLANS—The key factor in temporary support, particularly in the critical area within 25 ft of the face, is a plan for minimum support rigidly adhered to and supplemented with aditional support where there is any doubt that the mnimum is insufficient. The fact that nearly a third of the roof-fall fatalities occur where a timbering plan has been established is reason for emphasizing the need for supplementary support.

FACE-AREA SUPPORT—If coal is to be produced, both machines and men must work in the face area, which also means that timbering must be planned to permit reasonably efficient mining while at the same time providing maximum protection against all the hazards of newly exposed top whose condition is largely unknown.

Among the specific hazards are slips, clay veins, kettlebottoms and the like, aside from general weakness, as in the case of certain drawslates, clods and the like. Also, unless caught, certain roof members will separate and sag, thus requiring more attention than if they had been secured immediately. Swelling or disintegration as a result of moisture are additional difficulties that may crop up in face support.

Safety Posts. The first line of defense in face support is the safety post or safety jack. The latter has the advantage of being easier to install, as well as to move to permit machines to pass. Interference is relatively little with hand-loaded conveyors but increases progressively as mining moves toward mobile machines.

Scaling. An elementary precaution in face work is scaling to remove loose material—usually before or concurrent with the installation of safety jacks. Under some circumstances it is possible to mechanize part or all of the scaling—for example, by mounting a scaling bar on the head of a loading machine and using the machine crawlers to force the bar into the loose material and peel it down (*Coal Age*, August, 1958, p 140).

Crossbars. The crossbar is one logical answer to keeping support close to the face while at the same time keeping down interference. Where the coal is low, cross-barring, especially if weight sags the bars, may result in too-little clearance for mobile equipment. This has resulted, in some mines with poorer top, in conveyors being chosen instead of loaders.

Roof Bolts. Roof bolts also have the advantage, in most instances, of providing good support with maximum headroom. In many instances it is possible, by modifying the face cycle, to install them as the coal is loaded, starting for example, on the right rib as soon as enough coal is loaded to make room. In addition to independent bolting units, many continuous miners now are being equipped with dual bolters so that support may be installed as the machine mines the coal.

Face Shields. First advocated in *Coal Age* in a discussion of "Timbering for Safety in Mechanical Mining," March, 1945, p 89, the face shield is perhaps the most-logical

Roof and How It Acts

THE ROOF SUPPORT PROBLEM in coal mining varies with, among other things, the type of top. Really good top is exceptional, while poor is becoming more common. The material of which the roof is made up is of course a major factor in its strength. Clays are the villain it is now believed, since investigation leads to the tentative conclusion that where they are present and are saturated with water the roof is likely to be weak. Mine roof rock usually is water-saturated.

1. FALLS OF IMMEDIATE TOP—These result, among other reasons, because the top material is inherently weak, such as, drawslate or clod; because of cracks and cleavage planes; because of the presence of kettlebottoms, slips and the like; because of weathering; and as a result of such mining operations as pillaring. Such falls constitute the majority of the "accidental" type, and are the ones causing most of the injuries and fatalities, most of the operating interruption, and most of the cleanup expense.

One question with thin relatively weak roof layers over the coal is, "When to take down and when to leave?" Sometimes the material is so weak and crumbly that the question becomes academic, since there is no practicable way of keeping it up. Roof-bolting with channels, bars and short headers or cap-boards has made it possible at times to support top that otherwise could not be handled and which, when thick enough, rendered mining doubtful or impossible because of cost, hazard or both.

Depending on coal price, seam thickness and volume to be handled, a certain thickness of top material can be taken with the coal in room and pillar work. However, when this thickness reaches 6 in or more, the chances of economical production are considerably reduced if not completely eliminated. The rule, therefore, is to hold top material in working places, especially since support commonly is necessary for other purposes. There are exceptions, of course, to meet special conditions. In permanent or semipermanent openings, the answer is "Yes and no." One of the conditions, for example, which might lead to a decision to take top is a weak or crumbly drawslate over which is a good slate or sandstone. To save lagging of the slate, cleanup later on or both, the top would be taken to the hard material in installing support.

2. RIB AND FACE FALLS—An alternative form is sloughing which may be defined as minor face and rib falls, with spalling a minor form of sloughing. Rib and face falls also are of the type classed as accidental. Under certain conditions—thick, pitching coal, for example—such falls represent a real hazard. Sprags against the face and posts with plank stringers or lagging along the ribs are among the safeguards.

3. SQUEEZING—In its commonest form, squeezing is the slow increase in weight on pillars or solid coal eventually resulting in such things as crushing of the coal, heaving of the bottom and the driving of pillars into soft floor or top. The cause normally is leaving pillars or other support which, after considerable area is opened up, prove to be inadequate, permitting the top to settle gradually with transfer of the weight to active places and solid coal.

An alternative to squeezing is sudden collapse, which may also occur after a period of squeezing. Like squeezing, sudden collapse is rather infrequent, but it does occur, especially where thin room pillars customarily are left, or where a strong member in the top results in the creation of a large open area without a fall in pillaring. Preventives include ample pillar area and careful attention of getting initial breaks quickly.

4. BURSTS OR BUMPS—These are the sudden, explosion-like failures of coal as a result of internal stress caused by weight. In most instances, conditions conducive to bumping include heavy cover with strong members and especially a strong member close to the coal; a point at which weight and stress tend to concentrate, as the apex of two converging pillar lines, a barrier pillar sticking out into the gob, and so on; and a strong floor. As noted elsewhere in this "Deep-Mining Guidebook," drilling and augering can be used to trigger bumps or unload stress before it becomes too great. The basic line of defense, however, is adjustment of the mining plant to prevent stress buildup. Some suggestions are:

Get all the coal. Clean out timber also, since leaving props and cribs can help set up conditions conducive to bumps.

Mine pillars as fast as possible—at an even rate. The quicker pillars can be mined, the shorter period of time for stress development.

Orient the pillar line with the natural fracture system of the roof to promote caving in the gob, thus preventing the formation of long roof spans. If long spans cannot be avoided, some means of support should be provided to prevent breaking. Cribs are an example.

Keep development out of abutment of stress areas next to pillar lines and gobs, and develop for new pillars away from rather than toward such areas.

Adjust mining to prevent the formation of points on pillar lines. Keep lines even—no projections into the gob area.

Keep pillars as large as possible to reduce the chance of failure under stress. Uniform size and shape keeps stress even and prevents concentration on certain large or odd-shaped pillars.

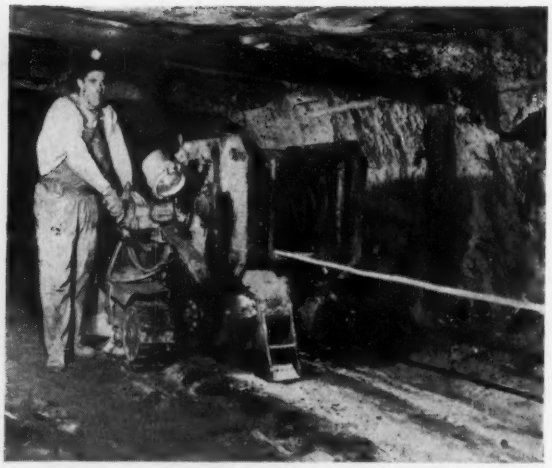
Mine individual pillars open-end where possible and keep lifts fairly narrow.

5. INTENTIONAL CAVING—Since caving relieves the remaining coal of weight—at least in substantial measure—and thus eases the job of mining and support where pillars are removed, much of the roof action in mining is intentionally induced. A common goal is a fall each time a lift is taken off a pillar, and this goal is fairly easily reached under conditions ordinarily encountered. Thus, support is provided to (a) break the top at the edge of the new lift and (b), with other support as necessary, to hold the top within the lift and keep it open.

Roof action in intentional caving commonly takes place in two to three stages. The first, or initial, break snaps the roof off at the breaker line. The cave commonly extends 25 to 50 ft up into the main roof. This is followed by a secondary cave, spanning several of the initial caves, and extending up to, say, 150 to 300 ft. If this is not sufficient to take the action to the surface, a third cave and general settlement normally occurs. Usually it is of sufficient magnitude to reach the surface unless the cover is exceptionally thick. Where subsidence is limited by packwalls or some other form of support, the initial strata may be cracked as a result of bending in the slow subsidence but falls of the type encountered in complete caving are relatively infrequent. Also, roof action, aside from a gradual and limited subsidence, seldom extends to the surface.



MOBILE TIMBERING MACHINES cut cost of adequate face support while facilitating adherence to standard plan.



TIMBER RECOVERY is facilitated by power winches mounted on crawlers or built onto gathering locomotives.

device for protecting men in the face zone. The original *Coal Age* idea was wire mesh on a frame supported on jacks. As now being developed by the Bureau of Mines, one modification is a frame with bars similar to fore poles on the top which could be moved up as the face advances.

Support Installation. Face support plans are almost infinite in variations but the general routine is to extend posts, crossbars or bolts to the face immediately after loading to protect the cutters, drillers and others engaged in preparing the next fall. Roof jacks may be used to protect machine operators specifically and saddle jacks may be employed under bars to permit movement for cutting with shortwalls. Then, after shooting, the top may be caught by safety posts or jacks (or bolts) as soon as an appreciable area is exposed by loading. Thus, support is provided whenever there is an opportunity for installing it.

Operator Protection. Protection for loader and miner operators who are relatively far back from the face, commonly is provided by bolts and/or crossbars spotted over the machine and either left in place or moved up. Use of bars of course is dependent upon sufficient height for clearance. Handling bars in the face zone, particularly where they are moved ahead each time a cut is made, is somewhat of a problem, particularly, if metal or heavy wood is needed for strength over the necessary open spans. As a result, a number of operators employ aluminum H-sections which are both stiff and light for high holding power and ease of handling. One mine, as an example, keeps two such bars in each place, moving them ahead when each cut is completed.

PILLAR SUPPORT—In addition to the regular protection of men, machines and working places, support in pillar sections usually functions as a top-breaker also. Coal itself is a form of support, either as stumps, wings, thin straight fenders, or sawtoothed fenders made by gripping or cutting out on the gob side, as examples. Frequently, a part or all of this coal may be recovered, and



HAND-PUMPED HYDRAULIC LIFTER here eases job of replacing heavy set. Truck mounting facilitates movement.

even if it is not, it represents a support cost considerably less than the conventional timbers or cribs. Artificial support, as in solid work, consists of jacks, posts, bars and bolts used much the same way, plus cribs and breaker timbers, both the latter primarily to break the top and at the same time protect rooms and pillar places against the riding over of caves.

Heavy weight or other special conditions may warrant special measures in roof support during pillaring operations. At one mine, as an example, the first step in mining a block open-ended is to crib it on the two sides next to the gob, supplementing this with similar cribs on a number of neighboring blocks.

Overburden at this operation ranges up to 1,500 ft in thickness and the immediate top is 40 to 80 ft of sandstone. At another property, the machine operator is protected in recovery of the final corner stump at the intersection of the pillar split and room by erecting cribs on each side of the space in which the machine advances in the stump.

ROOM AND ROOM-ENTRY SUPPORT—Depending upon equipment and mining plan, "permanent" room and room-entry timbering starts at from one cut up to 25 ft back of the face. Usual types are posts with or without capboards or short headers, and three-piece bar-and-leg sets. With topcutting in thick coal, legs may be eliminated by gripping out with the cutter bar to form slots into which the bars may be slid. Installation practices include placing all single posts on one side of the place to leave the other rib free for slabbing or pillaring.

STEEL SUPPORTS—Roof jacks until recently have been about the only substitute for wood posts in working places. Old rail has been used in the past and some attempt has been made to employ light shapes, corrugated strips and other steel members.

The advent of the coal planer and similar types of equipment brought the European-developed steel posts and steel post-and-header combinations into the picture in the United States. Their main application is on planer and slicer faces, but they are being considered in some quarters for certain other applications. Design features leading to such consideration included high load-carrying ability, provisions for yielding and thus guarding against sudden collapse through support breakage, and quick installation and release.

Timber Economics

If a place makes 25 tons and a post costs 75c to buy and the same to install, the cost per post is 6c per ton. Therefore, particularly where support recovery is not contemplated, support methods, materials requirements and possible recovery should receive intensive study.

Elimination of fatalities and injuries, and the promotion of efficient mining are, of course, the overriding goals and should not be jeopardized by stinginess in timbering. However, since saving even one post per

cut amounts to considerable money per ton, a change in the posting pattern—perhaps by staggering, as an example—can achieve this saving and still provide the requisite support and protection. Where bars and other more expensive items are involved, the desirability of close study and economy becomes even greater.

TIMBER INSTALLATION — Even though it may prove impracticable to reduce the number of timbers set—particularly crossbars—substantial economies in setting cost can be achieved by timbering machines.

In addition to mobile units, small hand-operated lifts have been developed for replacement and installation of cross bars in entries and gangways. They are designed for mounting on one end of a flat-bed car or truck.

Even without special machines, the timber crew's work can be lightened and its capacity increased by the use of timber jacks to take the manual labor out of raising crossbars. And in thick coal, where universal cutters are employed, the cutter bar may be pressed into service to lift bars into place.

SALVAGE—The practicability of recovering posts, bars and other timbering material depends on (1) whether it is safe, (2) whether, as with the customary untreated material, decay has left it with little useful life, and (3) the cost of recovery. If these and other questions can be answered affirmatively, recovery can then proceed, but only on the basis that adequate temporary support be installed before the post or bar is removed, or that removal be done from a safe point.

Removal sometimes is synchronized with making falls in pillar mining. Supports may be pulled one by one from a remote point using the old-reliable hand-operated post-puller, or "sylvester." Greater economy and the ultimate in safety is achieved by pulling supports in groups with a power winch, wire line, and chain or chains. Some coal companies, for example, have mounted motor-driven winches on old locomotives to convert them into mechanized pullers, while others have put the winches on crawler-type shortwall trucks.

Even with the best of equipment, recovery is only a fraction of the total timber installed, though a sizable one in many instances, with consequent over-all reduction in cost of posts and bars. In some instances, posts and bars have been reclaimed and reused as many as five times.

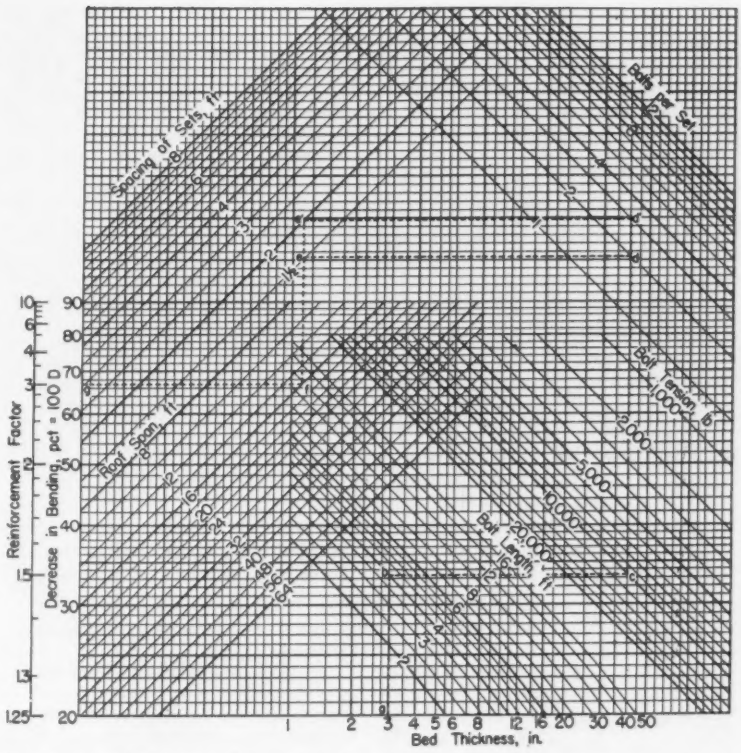
Roof-Bolting

Design the bolting pattern to give the desired protection yet keep cost of bolts and installation down.

Provide good anchorage and tension properly for maximum reinforcing power.

Check installations periodically to guard against loss of tension.

BOLTS broke into coal mining as a means of roof support in solid work. They then moved into support in pillaring and also are used to prevent heaving of bottom and the sloughing or caving of coal or rock ribs in shafts, slopes and entries. Bolts, however, are not a universal cure-all for roof troubles, and conventional timber or a mixture of bolts and conventional timber may be better from all angles under certain conditions.



BOLTING DESIGN CHART developed by U. S. Bureau of Mines facilitates design of bolting systems which provide the required support with a minimum expenditure for bolting materials.

Bolt Types

Roof bolts normally function by pinning a number of weak members together to form a strong beam. A somewhat rare function is hanging loose lower members to a strong upper member. In beam-building particularly, the desired result is attained by anchoring the bolt and then screwing a bearing plate up against the top. This, it will be recognized, puts the bolt in tension and makes the beam-building action possible. Unless the bolt is tensioned, there is no beam action, and unless tension can be achieved, meaning that an anchoring stratum or horizon must be found, other means of support normally must be employed.

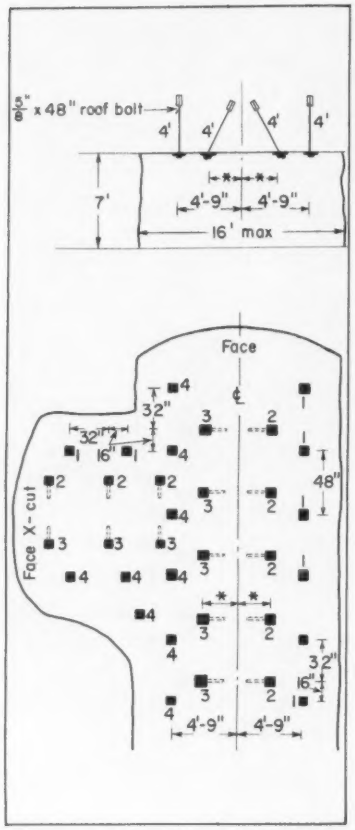
The object in bolting is reinforcing the roof and thus increasing its resistance to sagging and failure. If the roof is good it may be necessary to increase its natural resistance to failure only one-half, as an example, meaning that only a minimum of support is necessary. But as its natural resistance to sagging and failure decreases, the reinforcement factor increases. Thus, for top that is inherently weak, it may be necessary to install support that will multiply its natural resistance to failure as much as 3 to 4 times.

SPLIT-ROD-AND-WEDGE — Properly installed in rock of the right type, load-carrying characteristics of the split-rod-and-wedge bolt are excellent. It is easy to install and is not weakened in the installation process. However, it requires compressed air for driving and thus may require the purchase of compressor equipment. The extra step of driving the bolt into the wedge increases installation time approximately 20%, and cost of materials usually is higher. It loses its holding power more readily in the softer, semiplastic rocks and protruding bolt ends are a hazard, though they may be clipped off with special bolt cutters.

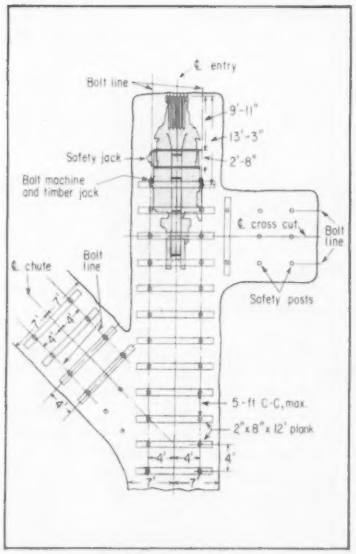
EXPANSION-SHELL—Requires no driving to anchor, is better suited to softer semiplastic rocks, is normally cheaper—about 25%—and can be installed in shorter time. However, it is more difficult to tension properly, and maintenance of tension is difficult in soft material.

BOLT SIZES—The usual sizes of bolts today are ¾ and ⅞-in. The ⅞-in bolt in high-strength steel has a maximum yield load of 9,040 lb, compared to 10,020 lb for regular-strength steel in the ¾-in size. In the ⅞-in size, the weight of 100 4-ft-long bolts, rolled threads, unchamfered square heads, is approximately 350 lb. The weight of 100 of the same bolts in ¾-in size is 510 lb. Thus, with the same holding strength the saving in steel is nearly 30%.

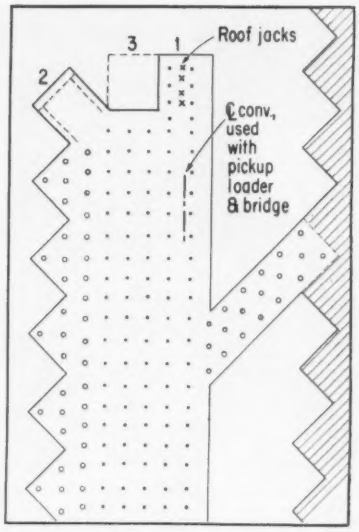
Plates usually are 6x6 in, though other sizes are employed. Embossing can give the same bearing strength with a considerable decrease in thickness, and consequent-



VERTICAL AND ANGLED BOLTS are involved in this concurrent plan for ripper machine. Bolts are set not over 4 ft apart.



PLANKS SUPPLEMENT BOLTS in this concurrent plan for drawslate and weak roof members. Safety jacks and bars protect bolters.



ALTERNATE-ADVANCE PLAN employs both bolts and posts for protection.

ly such plates are used by a number of producers.

The ⅝-in bolt, incidentally, offers another advantage where tension dropoff is experienced as a result of plastic flow of top materials, movement of top strata and/or shrinkage of headers (*O-B Haulageways*, September, 1956). This reflects the fact that the ⅝-in bolt has approximately 42% greater linear deformation than the ¾-in regular. Thus, if a 4-ft bolt of each type was installed to a tension of 10,000 lb, and roof movement later reduced the stretch in each by 0.030 in, the tension would drop to the following: ¾-in, 3,600 lb; ⅝-in, 5,300 lb. The higher figure for the ⅝-in bolt might mean the difference between failure and continued holding of the top.

CEMENTED BOLTS—A recent introduction is the cemented bolt. Cementing naturally increases the cost substantially but does insure a permanent anchorage, especially in soft strata. It is offered primarily for long-lived permanent openings where the extra cost is less a factor.

The design (*Coal Age*, May, 1957, p 120) is based on the use of a reinforcing bar instead of the conventional bolt, plus a perforated sleeve. The sleeve is placed in the hole and filled with mortar. The reinforcing bar is then driven into the sleeve.

Bolting Patterns

As with timbering, the pattern with bolting must be adjusted not only to conditions at each mine but also to variations within each mine. And since an individual bolt in place seldom costs less than $2, including equipment maintenance and depreciation, etc., saving even one per cut, provided safety is not jeopardized, is a worthwhile economy. By the same token, auxiliary forms of support should be omitted unless they contribute significantly to holding power and safety.

Where bolts are used alone, a check of published descriptions apparently indicates that the majority are placed on 4-ft centers, compared to 4 to 5 ft with crossbars and individual posts. Special patterns for long spans or weak top include the "Star" (a bolt in the center of a four-square pattern). Also, under some conditions, making part of the bolts—say every other one—longer may be helpful.

In one instance, in trim coal where 30-in bolts normally were employed, use of a 60-in unit in the center of each row helped materially. To install it was bent until the ends were at right angles, then fed into the hole while being bent back to approximately straight.

SUPPLEMENTRY SUPPORT — Even though bolting is one of the best support systems yet devised for holding the immediate top, which is its major function, it is manifest that bolting alone is not the answer to all support problems. One evidence is the occurrence of major roof-fall disasters where bolting patterns were considered satisfactory. True, the number of such falls has not been large, but they have helped focus attention on the following points:

1. The need for auxiliary timbering in many mines to help support the top and equally or more important to give warning of impending collapse.

2. The need for careful checking to keep track of changes in roof conditions so that the support system can be modified to compensate.

In fact, in a few instances, it has been found that conventional timbering is more reliable, easier to install and cheaper, in addition to the support and warning features, plus, in some instances, increased salvage of support material.

The type of roof has some bearing on the type of the supplementary support. For instances, with a strong anchoring member not too far up but with a tender roof immediately over the coal, or one that contains slips, cleavage cracks, kettlebottoms and the like, the bolts themselves may be used as the mounts for the additional support. This additional support takes the form of wood blocks, headers or crossbars, as well as metal auxiliaries, including steel channels, steel ties, heavy wire mesh, aviation landing mats, and so on.

Where there is a question of anchorage, or where there is doubt about the strength of the beam created by bolting, support independent of the bolts may be necessary. This takes in all the conventional forms, including single posts, bars and so on, including such special types as a crossbar held by a bolt at one end and resting on a post at the other. The latter practice was developed for pillar work, the post being set on the solid side to act as a breaker when the next lift is taken.

Continuous-Miner Plans

The continuous miner presents some tough problems in achieving support without interruption, and these problems are accentuated when conveyors are used for transportation. In return, however, certain miners contribute a benefit in the form of arched or elliptical openings which definitely increase the resistance of the top to sagging and failure.

Unless concurrent bolting is practiced, interruptions in the operation of the miners are almost inevitable if the operator is to be protected at all times by support. Consequently, the usual practice is to advance full-face machines to the point where the operator is under or only slightly beyond the last support, whether it be bolts, posts or bars. This means that the usual advance is 18 to 20 ft, after which the machine is moved back and the newly exposed area is timbered or bolted. An alternate place or places cuts down on the loss of time if the moving distance is not too great.

ALTERNATE ADVANCE—If the machine is not a full-face unit, the practice is to alternate advance from one side to the other. If a full-width cut is taken on each side it sometimes is feasible to bolt one side while the other is being advanced. Adjusting length of advance to bolting time makes is possible to synchronize so that the miner operator is never out from under protected top. If the place is being cut only head width, or width-and-a-half, it usually is necessary to stop and pull back or move to another place to permit bolts or timbers to be installed.

A combination bolt-and-post plan for alternate advance with in-cycle bolting is shown in an accompanying illustration. No. 1 lift is removed first, then No. 2 angled to the left, while No. 2 is driven, No. 1 is bolted, after four jacks are set on the centerline for temporary protection. When the machine drives No. 3, No. 2 is posted. Bolting of No. 2 is done while the conveyor is advanced, with temporary protection by the roof jacks on the centerline.

BOLT CENTERS — Bolts usually are placed on 4-ft centers with continuous miners; bars on 4- to 5-ft centers, where used. If single posts are employed, they usually are set in a row or rows equally spaced from both ribs, leaving a roadway in the center. With certain types of miners recessing of bolt heads and plates into the top is being practiced at some mines to keep them from interfering when a crosscut or pillar place is started.

Where only rooms are mined, some operators use the adjacent place as storage for bars, props and jacks. One, as an example, uses jacks and bars, picking them up from the preceding place as each crosscut is reached.

PILLARING METHODS—In pillar extraction, conventional bolting or timbering plans can be followed where pockets are driven and stumps are left against the gob for final recovery or crushing. In open-ending it may be desirable to adopt a special plan. One, for example, more suitable for full-face units, involves cribs and breaker posts to protect the open lift until extraction is completed. Another is based on bars bolted at one end and supported on a post or posts at the other—usually next to the gob. This system it will be noted, would be more adapted to ripper-head or to other non-full-face units. Or, the latter procedure might be reversed to put the posts on the solid side so that they could serve as part of a breaker installation for the next lift.

CONCURRENT BOLTING — Bolting units have been devised for installation on all types of miners, whether ripper, semirigid head or boring type. The mounts normally permit angling the drill in or out a maximum of 25 to 30 deg. The usual practice is to swing the unit out on one hole and install the bolt, and swing it in on the next, thus getting two rows on each side of the place, unless only one row on each side will suffice.

The key is sufficient speed in bolting to permit the job to be done before the machine has to move, if it is of the ripper or semirigid type, or until it advances beyond the slide or arm range of the unit on boring types. Normally, sufficient time is available to permit a good job of bolting, which can practically eliminate stopping the machine to install supports. The additional production can be as much as 20 to 25% where such bolting is possible. In addition, no member of the crew is exposed to open top with some types of installations, and only the bolters with others. Even then, the bolters are some 12 ft or so back from the face.

Two concurrent systems are shown in the accompanying illustrations. In brief they are:

Vertical and Angled Bolts. Two 4-ft-long ⅝-in bolts with expansion shells are set for each 18 in of ripper-machine advance. One bolt is angled over the machine and the other is installed vertically, the two bolters alternating. Maximum bolt spacing is 4 ft.

Bolts and Planks. Developed for use with a weak drawslate occurring with other weak roof members, this plan involves 2x8-in planks 12 ft long installed with ⅝-in 1040-steel bolts 6 ft long. The bolters are protected by a pair of steel rails on jacks ahead of the bolting stations. The planks provide excellent support and also a very-evident warning if trouble is impending.

CONCURRENT TIMBERING—In addition to bolting, concurrent timbering is being developed to prevent waiting or moving. Posts or posts and bars are installed in conventional fashion in cycle in the usual system. Special systems, however, include hitching on one side and supporting bars on posts on the other. In one instance, a boring-type miner was equipped with cutters making a 6-in slot 18 in deep on the hitch side to accommodate 4x14 H-beams 15½ ft long, using a post and wedge at the opposite end.

Designing Bolting Systems

Based on the results of model testing (USBM R.I. 5155, "Design of Bolting Systems," and 5156, "Reinforcing Bedded Mine Roof With Bolts"), the Bureau of Mines has developed a general procedure for designing a bolting system. Based on a roof-bolting design chart, illustrated, the procedure is:

1. Take as a first approximation of average bed thickness a figure arrived at by dividing the observed thickness of the roof section by the number of separate laminations. Use of the average results in conservative design. Laminations thicker than the average result in a higher reinforcement factor than the chart, which applies where all laminations are the same.

2. Choose a bolt length that will assure firm rock at the anchorage horizon. This may depend upon the results of tests (Item 3).

3. Conduct tests to determine bolt-anchorage capacity (R.I. 5040, slotted-type bolts, and R.I. 5194, expansion-type). Choose as the design value for the bolt tension either the anchorage capacity or the following, whichever is smaller: 10,000 lb for a wedge-type mild-steel bolt or 8,000 lb for a ¾-in mild-steel expansion-shell bolt. However, if experience shows a significant loss of tension after installation—say to 5,000 lb a month later—this lower figure should be used.

4. Choose the number of bolts per set so that the spacing within the set (span divided by the number) is not excessive. For most mines the maximum safe distance between bolts is estimated at 4 to 6 ft. The minimum bolts per set can be determined from roof-condition experience at the particular mine. A logical procedure would be to decrease the bolts per set in steps, each time decreasing the spacing as required by the design chart to keep the reinforcement factor unchanged. Bolt-to-bolt and bolt-to-rib spacing should be approximately equal in the set.

5. Choose a trial value for spacing between sets along the opening not greater than the spacing across the opening within the sets.

6. Using the desired roof span, construct the line A-B-C-E-F-G on the chart.

7. If the reinforcement factor is less than 2, decrease the set spacing and/or the roof span, and increase the number of bolts per set and/or the bolt length. A change in spacing and/or span will have a greater percentage effect.

Results achieved in bolting a particular roof should indicate whether the existing reinforcement factor, as determined from the design chart, is adequate or should be increased by modifying the existing bolting system. In the absence of previous experience the minimum reinforcement factor should be 2; otherwise bolting is not justified. Conversely, if the existing bolting system is judged to be effective, the design chart may be used to develop a system that is less costly.

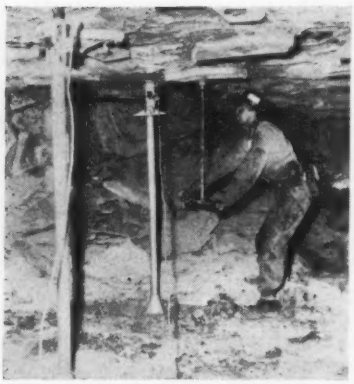
Bolt Installation

Split-rod-and-wedge bolts require a percussion tool for installation, which in turn requires compressed air.

Air still is the preferred medium for drilling the hard rocks encountered in mine roofs, even though electric rotary drills have been taking on harder and harder material. Portable compressors are widely used, though central stationary units have their advocates, who state that the advantages include plenty of air at rated pressure, lower maintenance and less trouble with dirt and water in air lines.

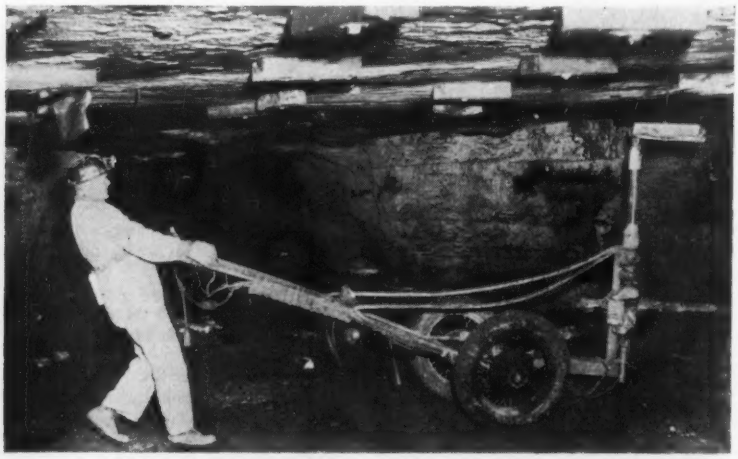
Portables may be mounted on rubber or crawlers, or may be carried in shuttle cars. They may be sized to operate one or two stopers, but in any event they should be capable of supplying drilling needs without drop below rated pressure.

Drill developments include a new hy-





BOLT RECOVERY with special jacks designed to be tripped and pulled out by ropes make the job easier, simpler and safer. Recovery stages using the jacks are shown in the three photos above.



MOUNTED WRENCH UNIT permits two men to recover an average of 600 bolts per day.

draulically operated rotary-percussion unit, which can be operated either rotary or percussion as desired, giving greater flexibility in choice of drilling type in relation to rock encountered.

Rotary Drilling—Ability to vary speed and pressure is a very desirable drill characteristic. In soft drilling, high speed and low pressure usually give the best results. In hard cutting, reducing rotational speed and building up pressure results in better cutting, especially with the proper design of bit head.

Length of drill should be as short as possible for maximum strength. Ejection of material in rapid drilling may make the use of a conveyor-type auger desirable. Spiral flights may also serve another purpose, i.e.: eliminating the offsets which tend to occur when passing from soft to hard rock, with subsequent breakage of bails as the bolt is run up. Spirals almost the diameter of the hole prevent this occurrence.

Proper operation and maintenance of rotary and other type of roof-bolters have a significant bearing on costs and results. If possible, the manufacturer should be afforded an opportunity to explain the operation of the machine to the maintenance superintendent, foreman and driller, with special attention to showing the driller the relation of thrust and rotation to penetration and bit wear.

Regular inspection, proper lubrication and cleanliness are basic approaches to the problem of keeping maintenance down. Also important is having the maintenance superintendent and manufacturer determine proper pressure adjustments. Pressures should be checked regularly and should be adjusted for changes in roof conditions.

Bits—Drilling with dull bits results in overheating and damage to the bits, in addition to damaging machine parts because of excessive stresses. Bits ground off-center or with one short cutting lip result in hole enlargement, making proper anchorage impossible in some materials. The same effect also results from allowing bits to spin or "dwell" too long at the anchorage horizon. Worn bits, loose-jointed drill extensions or drill whip can result in undersized, "dog-legged" or rifled holes.

1. **Work with bit manufacturers** to get the proper carbide and design.
2. **Consider the use of two or three sizes of bits** to reduce wear through loss of gage and speed up drilling.
3. **Match thrust and rotational speed** to conditions for maximum penetration and minimum bit wear.
4. **Employ trained men** for sharpening and reconditioning bits.
5. **Keep a bit-sharpening record,** and a record of holes drilled and bits lost or destroyed.
6. **Determine bit needs** per shift, all sizes.
7. **Provide driller with two strings of bits** so that while one string is in use the other can be sharpened.
8. **Use bit record** to determine if the machine needs adjustment, roof conditions are changing, or the driller needs instruction.

DUST COLLECTION—Of the two main methods of suppressing dust—water during drilling and dry collection—the latter is forging ahead because of the inherently greater complications of water. The simplest form of dry collector consists of a flexible collar held against the roof to collect the cuttings and drop them into a bag or onto the floor. More positive means of collection and disposal are provided by vacuum units operating through collars around the drills or, in the latest, by pulling the cuttings through hollow bits and drill steel.

Dry dust collection, however, has been found inadequate under some conditions though normally it is generally preferred. Drilling in hard sandstone at one operation, as an example, became impracticable with dry collection. Tanks and pumps were installed to feed water up through the hollow drill rod, making it possible not only to drill the rock but rendering dust collection unnecessary.

ANCHORING AND TENSIONING—Anchorages vary in accordance with the type of rock, with corresponding effect on the maximum tension possible. And without anchorage there is no possibility of achieving tension and consequently there is no reinforcing effect. Naturally, other things being equal, a better anchorage can be achieved in hard sandstone. In fact, in such material it is possible to break the bolt before it pulls out. In soft shale, the opposite is the case and the bolt will pull out before it will break. However, a certain degree of tension can be achieved even in soft material and this frequently is enough for the purpose, or

enough to reduce the need for supplementary timber.

Correct hole size is a major factor in good anchorage and ability to tension properly. Undesirable variations include oversize, undersize, "dog-legging" and rifling. Periodic checks with a hole gage is a major method of revealing such faults before they become serious enough to cause trouble.

Proper installation is another factor in good anchorage. With expansion-shell types, this includes positioning of the expansion units so as not to use up thread and thus increase the possibility of not being able to develop full tension because of running out of thread. Check plug and shell position periodically by removing sample bolts to see that proper anchorage is being achieved.

CEMENTED ANCHORAGE — A new development in anchoring expansion-shell bolts is enclosing the shell in an envelope containing a quick-setting plastic cement. As the bolt is run up the envelope is punctured and the cement fills the hole and hardens for a firmer anchorage in any type of top.

TORQUE REQUIREMENTS — Under average conditions, 50 to 80 lb of tension is developed for each foot-pound of torque. If 60 is taken as a conservative factor, about 150 ft-lb of torque will develop 9,000 lb of tension—well below the yield point of a ¾-in mild-steel or ⅝-in high-strength bolt, assuming the bolt bears against a plate that is level and that there is not excessive upward pressure to generate additional friction.

Torques up to 200 ft-lb may be employed in hard material, with some authorities suggesting around 170 ft-lb in hard shale and 150 to 160 in soft shale. In very soft top, where anchorage capacity is limited, bolts may be tightened with a hand torque wrench to determine the suitable setting for the bolting machine.

Bolt head and roof plate should be firmly against the top before tightening begins to make sure that the maximum thread length is available. Excessive torque may be wasted in hard top as a result of galling between bolt head and plate. If the plate is not level the bolt head may be twisted off at over 175 ft-lb.

Caution should be observed with wood headers to make sure that tension is preserved. Wood can dry out, yield under pressure and otherwise change characteristics with loss of tension. Never install a wood header, crossbar or capboard with a nut alone. Always use a steel bearing plate.

Other factors involved in good anchorage and tensioning include machines in good adjustment and the use of the correct bolts, shells and washers for the job.

CHECKING TENSION — The ultimate in accuracy and perhaps the best method of determining the efficiency of the bolting job is the pull test with a hydraulic ram. Between such tests a hand torque wrench should be employed at frequent intervals to check the accuracy of the torque setting of the wrench or bolting machine.

After installation bolts may lose tension for any of a number of reasons, including plastic flow of the rock at the anchorage point, movement of the strata, drying out or yielding of the headers, crumbling of protuberances under the bearing plate and so on. As noted, the handy device for spot checking to see if a tension dropoff warrants retightening is the hand torque wrench.

VISUAL INDICATORS — Two general types of indicators to show tension in bolting are now available. One shows only that initial tension is secured, and consists of a crimped washer, the crimp of which disappears when the correct tension is attained.

The second type shows not only that initial tension has been secured but also if any relaxation takes place in service. Such indicators, because of their cost, normally are designed for installation on approximately every 10 or 12 bolts. One device of this type consists of two circular plates between which a layer of rubber has been bonded. As the device is placed under tension of compression the rubber expands or contracts, and the relationship between tension and torque, or the relaxation of tension in use, can be determined by using a special compression-pad gage.

Another such indicator comprises specially forged self-centering-head bolts, specially embossed plates and concave steel-spring washers. They change shape as the load is applied and change back when tension drops to a certain value.

Bolt Recovery

Since, as with timbering, except on pillar lines, it is estimated that not more than one bolt in 10 is ever called upon to actually support top material, salvage almost automatically becomes a matter for consideration, since whether the bolt is holding top is a major factor in determining whether recovery is possible. Even if most of the bolts were supporting top, salvage would still be possible by installing protective support, but the hazards are substantially greater and the savings possibilities correspondingly less.

Recovery operations so far are limited almost entirely to the expansion-shell type of bolt. Under favorable conditions, recovery cost is ¼ to ½the cost of a new unit, including expenditures for new shells and nuts.

Hand salvage is the rule, and a basic principle is setting roof jacks or safety posts before any attempt is made to remove a bolt. A special jack now available can be tripped and pulled out by a cord (see accompanying illustrations; also *Coal Age*, January, 1959, p 120).

A second principle is at least two men to a salvage crew, since two heads can be better than one in guarding against hazards, and the second man, in case of trouble, can, in many instances, prevent an accident from turning into an injury or fatality. Experience so far indicates that a two-man crew can recover 200 to 300 assemblies in a shift.

Mechanized recovery units have been developed for some operations. In one, a standard drill with appropriate socket is installed at one end of a rubber-tired truck with the operation switch at the other. Thus, the men are back of at least two rows of bolts when removal takes place, and consequently do not need to set as many safety jacks or posts. With two men, it was reported, recovery was running 600 bolts per shift. No recovery is attempted under bad or doubtful roof. After the drill loosens the bolt, it is pulled out by means of a piece of copper tubing about 6 ft long.

Bending and head battering apparently do not militate against re-use of bolts. However, it is recommended that bolts be inspected for torsion damage, thread damage, flexure cracks and tensile failure particularly, and that threads should not be chased. Indeed, they should be wire-brushed and oiled. If afterward they will not engage properly the bolt should be discarded.

Coating and Sealing

Consider for protecting certain roofs in certain areas against the adverse effects of moisture and temperature changes.

THE SUSCEPTIBILITY of certain types of roof to changes in moisture and temperature is so pronounced that a number of deep mines in the past have installed elaborate conditioning units to insure uniform humidity and temperature. More recently, even though the idea is old, a number of operators have turned to coating and sealing to prevent roof and rib deterioration as a result of these influences.

Coating and sealing products include vinyl compounds, coal-tar products and mastic-type materials—all sprayable with or without heating, usually because they are dissolved in a volatile compound which evaporates after application. Because solvents normally are flammable or explosive, or both, care must be taken in application. Also, care must be exercised to see that after application the material will at least not propagate fire even if ignition cannot be prevented. A number of products now on the market meet this standard and are being employed.

Careful scaling and dryness are major prerequisites to good sealing. Though it provides no support, sealing has cleaned up some very costly roof and rib disintegration situations at a number of mines where conventional timbering failed to do the job. Cost varies from 15c to 20c per square foot minimum at most operations, including scaling and other preparations. Usual practice is to seal the top and carry the coating 6 or 12 in down each rib for insurance. At some mines, all the coal ribs are sealed to prevent sloughing. One of the incidental benefits is a smoother surface, which helps ventilation.

Injection Bonding

The major objective in bolting, as previously noted, is binding several thin, weak layers together to make a thicker, stronger roof beam. In essence, the process is the same as making plywood, which logically led to the idea of bonding roof members together much as the plies are glued together to make plywood.

The bonding is done by injecting the bonding agent under pressure through drill holes at appropriate intervals and of appropriate depth. Experiments so far indicate that the idea has good possibilities. If further work confirms this, bonding may be the new and more-efficient approach to reducing or preventing roof falls.

Transportation with Economy

Operating Aims

A haulage system with the capacity and reliability necessary to take all the coal the face units can provide with no interruptions.

Facilities and equipment that represent the minimum investment, require minimum operating labor, are safe to use and are low in maintenance cost.

Approaches

Install equipment with the necessary capacity to handle normal peaks in addition to the regular-rate flow of coal.

Eliminate interruptions or reduce them to negligible figures by such things as conveyors of the extensible and bridge types, pickup loaders and high-capacity haulage units.

Automate, as at transfer points, use big units and take other steps to reduce haulage labor.

Practice Trends

Conveyors still gain for face and panel service, though shuttle cars with or without pickup loaders still handle a significant tonnage. AC cars being used in increasing numbers.

Automated transfer stations and trip handling more and more the practice.

Main-line haulage still the province primarily of cars and locomotives, with belt slopes for hoisting. Where shaft hoists are employed they are being made automatic.

Face Haulage

Aim for the maximum degree of continuity by the use of continuously operating equipment or by use of the largest possible mine cars or shuttle cars, plus layouts which keep changing time to a minimum.

ALTHOUGH MINE CARS have moved into a minority status in serving face units, some of the lessons learned in attaining maximum efficiency with them apply with equal force to their successors. One lesson is use of the biggest car possible to cut down the number of changes and thus increase loading time. A second is a haulage layout providing at the best a changing point no further back than the next crosscut, and at the worst no farther than 150 to 175 ft back. One contribution to the short change with cars was the development of prefabricated track layouts, which practically guaranteed a changing point at every crosscut.

Shuttle Cars

As with mine cars, the bigger the shuttle car, within limits set by seam and other conditions, the fewer the changes and consequently the fewer the interruptions in mining and loading at the face. Also, as with mine cars, the closer the changing point, assuming the usual two and sometimes three cars per unit, the higher the efficiency.

New types of cars include the 6-wheeled unit hinged in the middle to increase capacity in low coal.

Regular AC and torque-converter cars not only offer advantages of simplicity and low operating and maintenance costs, but facilitate AC use.

SURGE CARS, PICKUP LOADERS—To compensate in part for the interruptions inherent in hauling with wheeled units, some form of storage may be provided behind the loader or miner. The mine bottom is one form of storage, in turn bringing in the pickup loader. Even with the cost of the loader and operator, the increase in miner performance has been sufficient in many instances to show a handsome gain.

The surge car is a possibility under some circumstances but is not a cureall. The car may be a standard shuttle car or a specially built unit. Whether to use a surge car can be determined only after a careful study.

HAULAGE LIMITS—The maximum length of shuttle-car haul is approximately 500 ft with two cars per face unit. The tendency, however, is to keep the maximum under 400 ft where possible because of excessive loss of miner or loader working time as room depths near their limit. This may be offset in part by introducing a third car, which, however, requires extra investment in equipment and labor, and very careful organization of the haulage system to prevent interference. However, some operators use the third car quite successfully. One, as an example, operates the third car as a combination unit. In other words, it works part of the time moving coal and part of the time bringing in supplies.

The cable-reel limit can be stretched by anchoring the cable at the midpoint and backlashing on half the run. Some operators who have tried it recommend against the practice not only because the long hauls raise loader waiting time, but because backlash reeling is more difficult and is harder on cable, guides and reel. Therefore usual practice is to anchor at the discharge point. Shock-absorber-type anchorages are great cable savers, incidentally.

Though the ultimate savings at any particular operation depend upon the mining plan and conditions, the possibilities in keeping shuttle-car distances short may be substantial. For example, extra moving of transfer stations to keep distance down by 200 ft per round trip might cost, say 1½c per ton, while the reduction in face cost as a result of higher machine output might be 10c. Separate travelways, where possible, also contribute to speeding up shuttle-car service and thus increasing face output. Under at least some conditions, as shown in accompanying diagrams, it is possible to arrange hauls so that it is never necessary to go through curtains or doors.

TRANSFER TO MINE CARS—Unless the track is sunk, an elevator or ramp is necessary for transferring from standard shuttle cars to mine cars. Sinking is done at some mines, and normally where this is the practice an effort is made to have one station serve places in both sides of an entry. The same practice also is followed where the top must be shot to permit the use of elevators or ramps. To keep the shuttle-car haul down to the minimum, sta-

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Shuttle cars . . . Battery tractors . . . Conveyors . . . Extensible conveyors

Trip Loading . . . . . p 244
Trip movers . . . Track layouts . . . Automatic loading . . . Switching coal

Main Haulage . . . . . p 245
Rail haulage . . . Track . . . Haulage control . . . Belt haulage . . . Belt operation

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Belt slopes . . . Shaft hoisting

Handling Men . . . . . p 249
Hoisting . . . Car transportation . . . Belt

tions normally are established at intervals of 200 to 300 ft. And also to reduce top-shooting as much as possible, at least one operator has developed a low-type elevating unit mounted on a crawler-type mining machine truck (*Coal Age*, September, 1955, p 72). A high-speed conveyor is provided to eliminate slowing down or stopping shuttle-car discharge. In this instance, transfer stations are prepared by the development crews every 120 ft.

Making it possible for the shuttle car to discharge at maximum rate without stopping is, as noted, a major element in keeping an operation up to maximum efficiency. If elevator capacity is low, a hopper should be provided—usually by sinking the boot into the bottom. Or the chain should be speeded up. Provision also should be made for changing mine cars without stopping the elevator or shuttle car. Making shuttle-car and mine-car capacity match is one method being used at new mines or where cars or shuttle cars are being replaced. This method is especially effective with elevating-discharge cars, but works well with any other type of transfer equipment.

TRANSFER TO BELTS—A number of mines apparently encounter little difficulty in side loading belts from shuttle cars, but a greater number limit belt loading to end-on only, with usually a special hopper or a hopper-tailpiece combination to start the coal on its way. Side loading, these operators contend, results in greater spillage and, because the coal comes on at 90 deg, is harder on belts.

Where side loading is practiced, with the belt in the center of three headings, it is possible, by assigning a crosscut on each side to a shuttle car, to load at four points, provided the crosscuts are offset. Also, with two cars, one may be assigned to the end position and the other to a side position in the next crosscut down to keep them apart at all times. Other systems are of course possible, and include the end- and side-loading types for three cars shown in accompanying illustrations.

In end loading, with auxiliary hoppers, there is an opportunity to install a grizzly to pad the belt with fines before the lumps hit. To load belts, either side or end, a low ramp or an elevating-discharge car is necessary. A saddle-type hopper that can be moved along the conveyor (*Coal Age*, February, 1957, p 108) can help materially when it is necessary to shift side-loading stations often.

Big lumps may be a problem in transferring from shuttle cars to belts. One answer is a portable grizzly on legs into which the car discharges. An attendant is necessary to break the lumps, but some operators believe his cost is more than repaid by less belt wear and damage (*Coal Age*, May, 1959, p 72).

Unless belt speed and width are sufficient to move the coal as fast as the shuttle car can discharge, delays are bound to occur. To prevent these, and also to improve belt-loading conditions, a number of steps may be taken. One is to install a two-speed motor with automatic timing control to speed up the belt while the shuttle car is discharging and cut it back automatically afterward.

Transfer conveyors or elevators capable of taking maximum shuttle-car discharge, and at the same time designed to feed to the belt at the proper rate, are used at a number of mines. Conveyors may be of the belt, chain or shaker type, with or without hopper and with or without two-speed controls. A recent unit consists of a hopper with dual conveyors converging in a throat at the discharge end (see illustration). The design automatically provides slow feeding to the belt with fast acceptance from the shuttle car.

Incidentally, where a number of elevators or conveyors discharge to a belt, it is possible to interlock to prevent simultaneous operation and over-loading of the belt by the outby unit. One mine uses a skate wheel on a flat spring under the top run of the belt (*Coal Age*, May, 1951, p 83). When the belt is loaded, the spring is depressed to hold in a button locking out all elevators except the one in use. As soon as the belt clears, the button is released to permit another elevator to start automatically.

Another system (*Coal Age*, December, 1958, p 144) also employs a wheel to sense changes in belt loading. Through an arm, solenoid-operated contactors, resistors and a shuttle-car acceleration switch three side-belt operating speeds are automatically provided and overloading of the main belt is prevented.

Other suggestions are finger or paddle switches actuated by being struck by coal to prevent an elevator or a crossbelt, from pouring coal onto an already loaded main belt.

SHUTTLE-CAR ROADS—Ruts, dust and mud are the major difficulties in building and maintaining shuttle-car roads. A good rut preventive used at many mines is to sling a section of light rail or angle crosswise underneath the cars and just clearing the bottom, using chain or wire rope.

Where there is much mud, planking is the usual answer, normally with 2x8's or 2x12's on stringers of the same material under the tire tracks. Spaces of, say, 3 in between planks reduce the number necessary and also provide places in which to lay cables serving other machines that might use or cross the roadway.

Battery Tractors

Rubber-tired trailers or trailer trains pulled by battery tractors are among the developments and modifications of the original shuttle-car idea. They were developed primarily to meet the problems of the small drift mines in coal under 36 to 40 in, with some in 24 in or less.

Before the train idea was evolved, a number of designs for a low-cost shuttle car for such operations had been developed. Also, tractors were developed for pulling bottom-dump trailers.

The battery tractor is used to pull up to 10 trailers (*Coal Age*, January, 1959, p 86). It acts like a gathering locomotive also functioning as a mainline haulage unit. Both three-wheeled and four-wheeled trailers with lift endgates are used.

Conveyors

BRIDGE CONVEYORS—By providing a continuous and continuously functioning connection between loader and room conveyor, and by relieving the operator of all but the responsibility for keeping the machine in coal, the bridge unit has resulted in major increases in tons per man at the face. A typical bridge plan appears in the "Mechanical Mining Planbook" elsewhere in this issue.

Evolution of the bridge unit has included development of the tandem and mobile bridges, the latter being able to advance and retreat under its own power. Both chain and belt types are now available, and may be connected to the face unit by a suspended bridge or, as with one type of belt, may take feed from shuttle cars, thus reducing the number of transfer-station moves. These units also are known as "mobile chain feeders" and "mobile belt feeders."

One combination of bridge and other units providing up to 150 ft or more of distance between face and room unit consists of a 40-ft bridge unit, a bridge carrier and a second 40-ft bridge, plus a mobile room conveyor 120 ft long. As the latter moves up it pulls out up to 50 ft of extensible belt. Plans showing one of the units in entry driving and room work appear in the "Development" and "Mechanical Mining" planbooks elsewhere in this Guidebook.

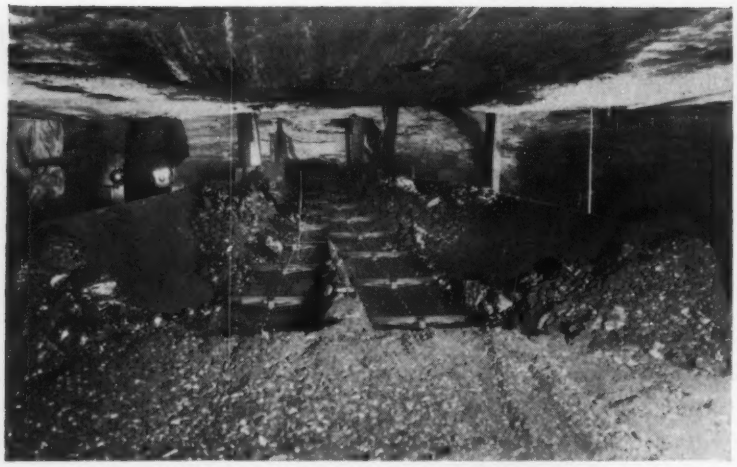
ARTICULATED AND CASCADE CONVEYORS—Development of the continuous miner and accompanying emphasis on development of conveying mediums also has resulted in the design of articulated and cascade conveyors and conveyor systems. One version of the articulated conveyor developed for a boring-type miner consists

Field Reports

Cutting Travel Distance—New 540-ft shaft with pushbutton elevator, plus 50x110-ft portal building (265 men on all shifts) and a new 8-ft fan improve ventilation, cut travel distance 3½ mi and raise tons per man 20%. *Coal Age*, September, 1959, p 110.

PVC Belting—How five different companies use PVC woven-nylon belting, how the belting is constructed, and what results have been attained in service. *Coal Age*, April, 1960, p 100.

Automated Hoisting—How single pushbutton sets in motion automatic hoisting sequence at deep mine, including car hauling and dumping, skip loading, hoisting and skip unloading. Both coal and rock are handled automatically. *Coal Age*, June, 1960, p 108.



DUAL-CHAIN FEEDER for use between shuttle cars and belts automatically provides slow and fast rates.

of a series of interconnected belt conveyors on wheels, each with its own driving and propelling motors (*Coal Age*, January, 1954, p 64).

The cascade system is substantially similar, but has some differences. One is in the fact that the conveyors need not be coupled, though hitches are provided to permit the train to be pulled behind the boring unit in one remote mining system. To avoid inserting and removing conveyors one at a time, the latest idea in remote mining is to store the conveyors in a structure with circular ramps. As the machine goes in it pulls conveyors off, pushing them back up on the way out.

Extensible Conveyors

Development of the bridge unit was the first step in really bringing the conveyor into the picture as a means of serving loading machines and continuous miners. The next step was to design the room conveyor so that it could be easily extended to keep up with the face unit. The first such unit was the extensible belt, first with standard angle, channel and plate frames. Recently, the rope type has taken over almost completely.

Chain-type conveyors of the extensible type are a recent offering (*Coal Age*, May, 1957, p 111). In this unit, made up of sections mounted on rubber-tired wheels, each section has a gooseneck in the middle, with the raised rear end riding on the low front end of the succeeding section. This results in an extension of approximately 50% of the length of each section.

With the bridge conveyor followed by the extensible unit, a continuous conveying route is provided from the mining unit to the transfer point or main line. Advances up to 1,000 ft can be made without moving out of the place and without any other operations than adding stands and belt. Sections of belt and stands 100 ft long, permitting advances of 50 ft, usually are added in less than 5 min. Plans for taking pillars with extensible belts are included with other plans in the "Development" and "Continuous Mining" planbooks elsewhere in this Guidebook.

Trip Loading

Set up system that will prevent delays to face units. Conduct such loading with no men, if possible, and in any event with no more than one.

Trip Movers

Various systems and units for moving trips past loading stations, whether they be ramps, elevators, belt discharges or what have you, include the following among others now used:

1. Gravity—Possible but hazardous with the usual spragging.

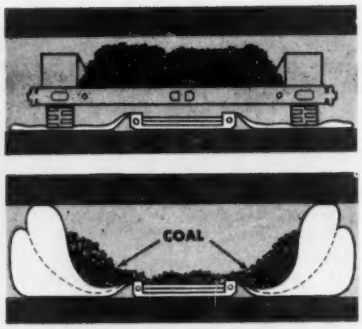
2. Gravity Retarding—Feasible with a rope and a brake drum with manually or motor-applied brake.

3. Operator-Controlled Locomotive—Fairly widely employed in the past and still employed in a number of mines. Ordinarily means an extra labor cost unless the same motorman pulls to sidetrack or outside in which case care must be taken to see that the trip-changing interval is not too great. Complete looping of track, discussed more fully later in this section, facilitates this trip-moving scheme.

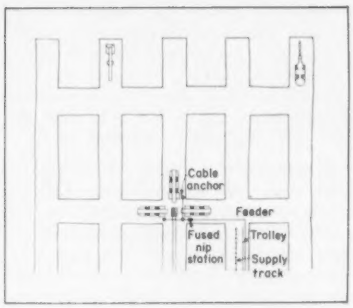
4. Remotely Controlled Locomotive—Machine with brake set up as required and with the controller on the first point, on separate section of wire which is energized to move locomotive and trip by switch operated by boomman or attendant.

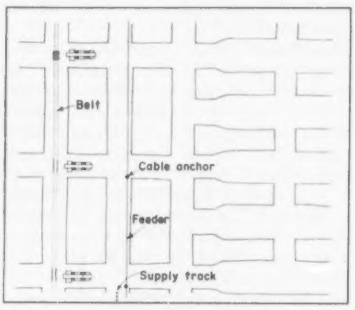
5. Remotely Controlled Trip-Spotting Hoist—Sometimes accompanied by smaller hoist to pull rope back for coupling to fresh trip.

6. Barney, Chain-Feeder and Ram-Type Between-the-Rails Spotters—Newest in the line of trip-moving equipment, these units are positive and accurate in operation and permit designing transfer stations for maximum efficiency in trip changing. The changing function can be preset or controlled by limit switches for precision and also for automatic performance if desired. Also such equipment lends itself to operation by shuttle-car drivers, and thus, even if not made automatic, requires no special attendants.



PNEUMATIC FEEDER facilitates coal transfer in low seams.



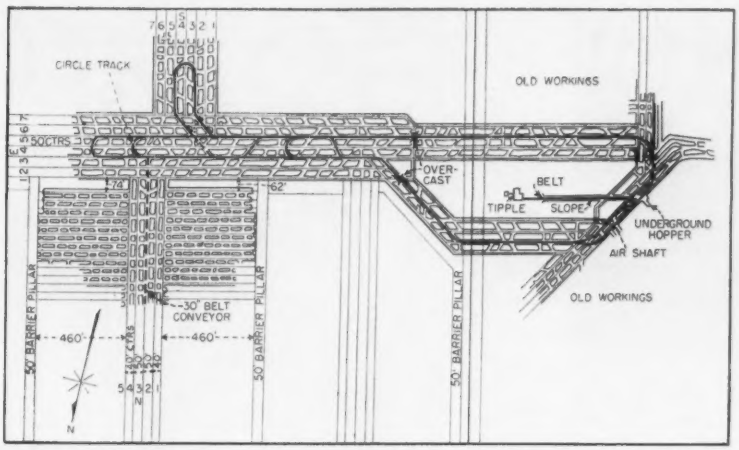


END AND SIDE DISCHARGE for shuttle cars to belts. All cars have their own routes. Three cars can be accommodated.

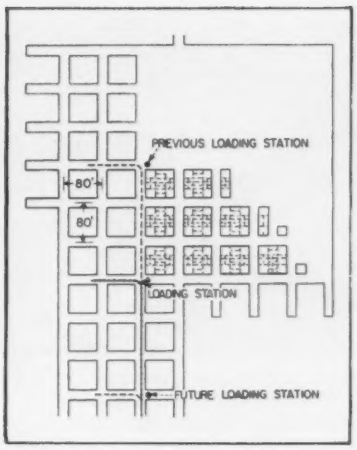
Track Layouts

The simplest form of track layout for car or trip loading is the tail-track system. The track can merely be extended down the heading, or it can be turned right or left, as shown in an accompanying plan, or it may be turned right or left and then turned back U-fashion in an adjacent heading. The major disadvantage is that trips must come out the same way they go in, meaning increased loss of time unless the changing track is very close.

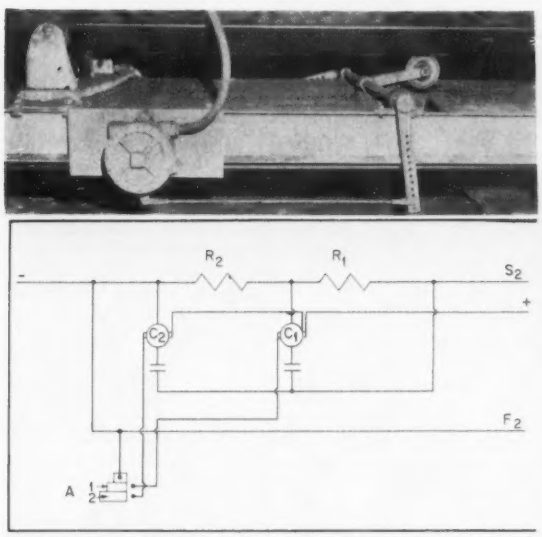
Sidetrack or loop-track systems (see accompanying plan and also the "Development," "Continuous Mining" and "Mechanical Mining Planbooks") provide access from both ends, and thus permit the quickest-possible trip changes, with no time loss at all if properly set up. The sidetrack —if that is the system—may be in the same heading as the main track. More



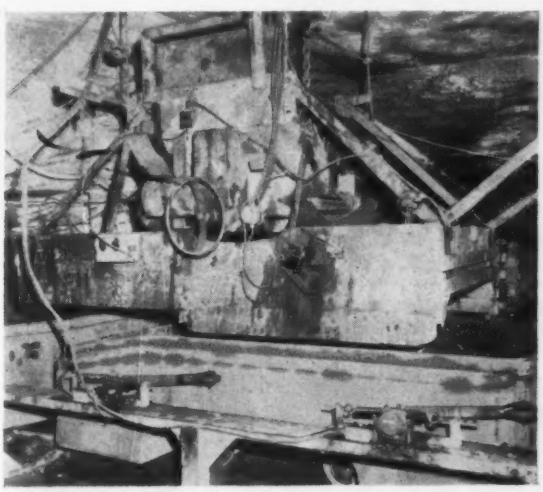
TRIP-LOADING PLAN illustrated above involves circle tracks around the beltheads, permitting locomotives to move trips continuously without storing empties. The loop is completed at the slope bottom.



SIMPLEST TRIP LOADING is tail track, turned 90 deg through crosscut, as shown in this plan.



PREVENTION ON BELT OVERLOADING is accomplished in this system by load-sensing wheel and electric control circuit (*Coal Age*, December, 1958, p 144).



ALL-ELECTRIC AUTOMATIC loading point provides unattended trouble-free car loading. Steel swing flaps in hood control spotter operation as coal builds up.

usually, however, it is in an adjacent heading. Or the sidetrack may, in effect, be made continuous by tracking the second heading and installing chutes and crossovers at intervals. Double tracking represents some extra expense but does result in greater flexibility and quicker trip changes.

Automatic Loading

Complete loading of trips without any operators or attendants whatever already has been achieved in coal mining. Now, the number of such installations is increasing at a fairly rapid pace. Late-type underground stations include facilities for automatically diverting the coal from one car to another, controlling the hoist moving the trip, and starting and stopping the belts. Even cars off the track are provided for.

Switching Coal

The problem of switching coal flow one car to the next in continuous trip loading can be met in a number of ways. One is the overlapping mine car or articulated trip in which facilities to bridge the gap are built onto the cars.

Where the coal flow is not too great, means of preventing spillage during car change include a simple plate or chute to catch coal during the change.

Heavier flows of coal, as off a mother belt, usually require power or some other type of equipment for a quick change. Power equipment includes the short reversible conveyor mounted transversely under the head of the main belt. Equipment without power includes a "pants chute" with flop gate to divert the coal stream from one car to the next.

Main Haulage

Use big cars and high-capacity locomotives for minimum haulage cost.

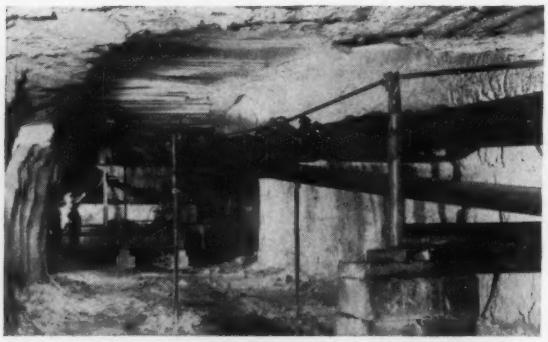
Provide track that will permit high-speed operation with a minimum of maintenance.

Consider belts for main and secondary haulage, especially the latter.

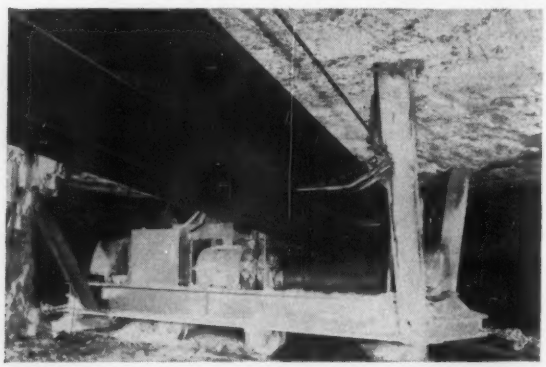
Rail

ONE-STAGE OR MULTISTAGE? — Main haulage usually is in two stages, relay and main-line, with a few operations dividing it into relay, secondary and main. There is a disposition, however, to question whether multistage operation should be adopted automatically. One-stage operation requires heavy track to the belt head or other loading station, but the extra cost may be much more than offset by decreased haulage labor and maintenance costs.

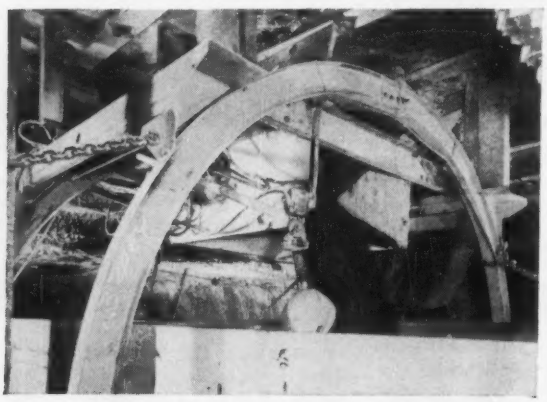
CARS AND LOCOMOTIVES — Even though cars are less and less taken to the face, where size has an appreciable effect on loading-machine productivity, capacity still is an important factor even in main-line service. One argument for the biggest possible car is that it costs relatively less to buy big cars than small cars. A second is



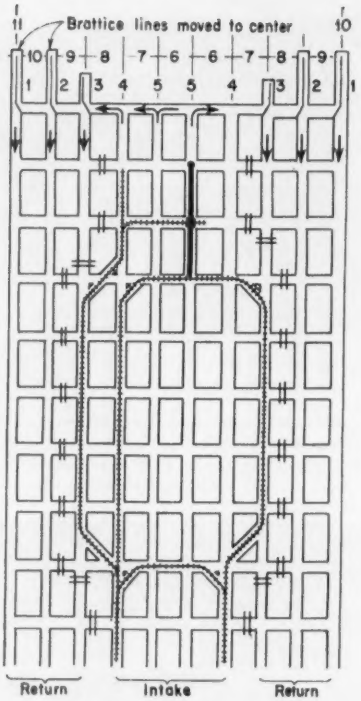
PORTABLE-HEAD CONVEYOR discharges at left into mine cars where automatic loading controls swing flopgate to prevent spillage between cars. Drive is out of picture at right.

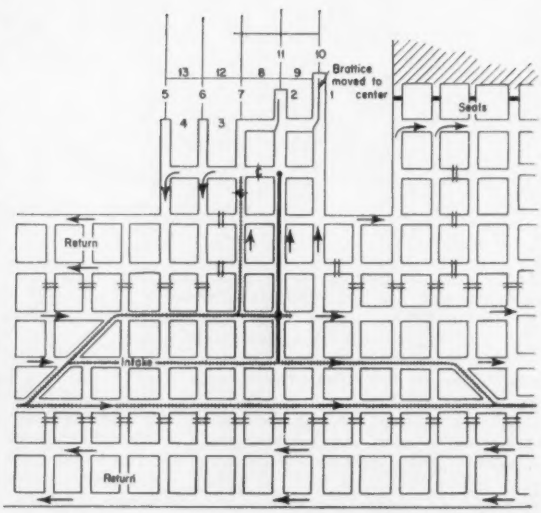


DRIVE UNIT of new belt operates from truck which is anchored in position in tracked crosscut. Unit can be moved in 4 manshifts.



ARCH UNIT, straddling main line track, supports discharge pulley, flopgate chute and other equipment of portable-head conveyor belt for coal-mine application.





TRACK AND MINING PLANS for portable-head conveyor show how spur is provided for mounted drive. Plans also illustrate shuttle-car haulage without going through curtains.

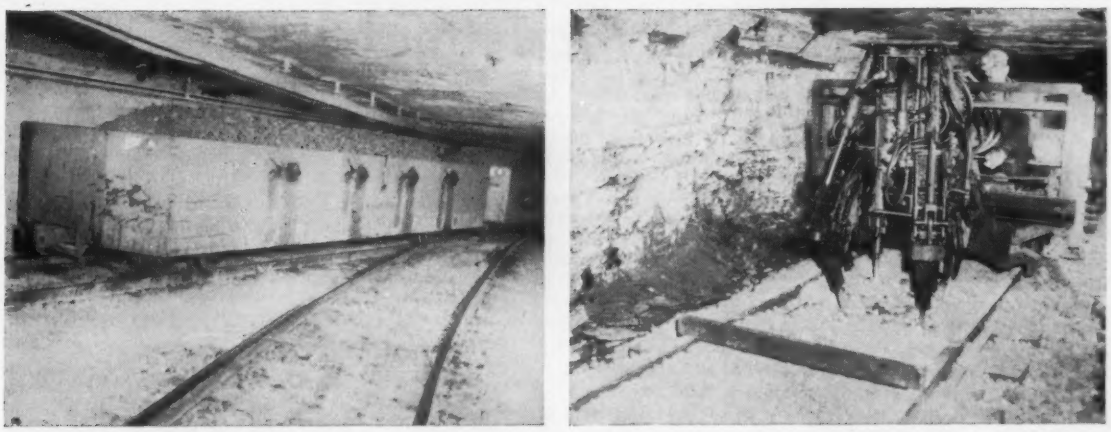
that the big car holds more coal per pound of car weight, and therefore less dead metal has to be dragged around for the same coal.

In the case of locomotives, if one big one can replace two smaller ones, there is an obvious saving in labor. Or two smaller units can be made into a tandem job to get the same saving. In at least one instance also, three small machines were tripled into a single 12-mph unit with spectacular savings.

Aids to safety, efficient operation and low maintenance in car design include:

1. **Automatic couplers.**
2. **Spring draft and buffing gear.**
3. **Antifriction-bearing wheels.** With high speeds and swivel trucks, as in 8-wheel design, wheel metal and treatment becomes a more critical problem. Answers include special mixtures and chilling with cast iron, and cast or forged steel.
4. **Lightweight corrosion-resisting materials.** Newest is aluminum plate, shapes and extrusions for maximum weight reduction. Another form of construction for simplicity and strength with minimum weight is the use of standard structural shapes—for example, channels for sides and ends on low-vein cars.

Antifriction bearings also mark the modern locomotive, which, especially in main-line service, tends toward a higher rated speed, usually 12 to 15 mph, with certain types rated up to 35 to 40 mph. Modern



TRACK-CONSTRUCTION COST-CUTTERS include ballast-spreading car (left) and mechanical tie tamper, which also facilitates alignment and leveling.

electrical controls include provision for dynamic braking where grades warrant. For absolute reliability in such braking, a 32-V battery permits continued operation even when trolley power fails.

Haulage Control

Except where the haulage system is of the simplest type, the dispatcher is essential not only for efficiency in haulage but also as a means of keeping a finger on conditions and progress throughout the operation for the benefit of the foreman and superintendent. In his business, he uses not only the regular telephone but, along with other mine personnel, the carrier-current phone—on locomotives and cages as well as in offices and stationary communication posts throughout the mine.

Ready communication with locomotive operators is the great advantage of the carrier-current instrument, the use of which some mine managers have stated has raised output and efficiency 10% or more.

Block signals at times can take over in part or completely in control of haulage, aside from their other major function of preventing interference and collisions. Normally, however, in the control area, they supplement and round out the dispatching program, making it, in the experience of many mines, more accurate and efficient.

Belt Haulage

ROPEFRAME CONVEYORS—Reducing the weight, bulk and complications of the conveyor structure has of course been the goal of the designer since the first belt conveyor went into service. The need is specially great in the thinner coal where the belt has some added advantages.

Conveyor sections have been progressively lightened and redesigned for quick assembly and disassembly. The use of a wire rope as the carrying member for the top-strand idlers is the latest step toward simplification and reduction of weight and bulk. In addition to a greatly reduced first cost the advantages include a major saving in installation time even though the same care is taken—as it should be—with alignment and other installation requirements.

Special low-type units have been designed as part of the evolution of the rope belt. The conventional-frame conveyor, however, still has its adherents, who note that the advantages of lower cost, ease of installation and resilient mountings are offset, at least in part, by offcenter operation of the rope unit as a result of offcenter loading, edge wear on belts and more attention in service.

PORTABLE BELT HEADS—A new development with the ropeframe conveyor is the portable belt head. The first such unit was designed for 2,000-ft-long 36-in mother units specifically designed to receive coal from shuttle cars and discharge into large mine cars. The basic elements are common to most conveyors but the arrangement makes the difference.

The drive section, including motor, controller and power-transmission facilities, is mounted as a complete unit on a rail truck. To move it into position, it is trammed to a spot in the first crosscut inby the main line, which means that the drive is 60 to 100 ft from the belt discharge. The drive stays on the truck, which is anchored in place while remaining on the rail.

The discharge pulley, together with a flopgate chute, are integral parts of a knockdown arch unit which is set up to straddle the mainline track. The arch, flopgate chute and pulley assembly are hauled to the site on a mine car. The arch then is set up and the two-way chute and pulley mounted in place.

Wire ropes are then attached to the arch and are strung out along the entry, passing over the drive. Two or three adjustable supports are used to hold the rope between the discharge and the drive. The remainder of the conveyor is the standard ropeframe unit.

One move involved shifting the entire 2,000-ft-long unit from one entry to another and setting it up ready for use. Total labor required was less than 4 manshifts. In contrast, the usual requirements for the conventional rope unit is 30 manshifts or more.

Belt Operation

One secret of efficiency in mainline belt haulage is proper installation according to the recommendations of the conveyor and belt manufacturers. Another is the employment of one man properly trained and equipped to patrol, service and lubricate each 1½ to 2 mi of belt line. A third is proper loading of the belt. Chutes should turn the coal in the direction of the belt, lay down a cushion of fines and, if possible, put the coal on the belt at the same speed. In a few high-tonnage systems, short speedup belts are used to turn coal from panel belts and deposit it on the mainline units in the right direction and at the right speed. Thus, the punishment is largely confined to the speedup unit. Big lumps, incidentally, require a wider belt, a heavier carcass and proper covers. Cushion idlers at transfer points are essential in helping protect the belts. Good splicing is a must.

The most effective method of determining motor and/or belt overloading, particularly with panel belts, is reading the motor current with a tongtype or other meter. Stuck idlers, piled up loose coal rubbing on the belt, and belt rubbing against the frame are common causes of motor overloading. Another, in addition to piling on too much coal, is too much belt for the grades.

FIRE PROTECTION—In addition to the already-accepted methods (*Coal Age*, March, 1958, p 122) the first line of defense against belt fires today is use of fire-resistant cover and impregnating materials. Those employed in belts approved by the USBM are two:

1. Neoprene.
2. Polyvinyl chloride (PVC).

Neoprene already has found substantial use and PVC is coming into the picture, particularly in the form of the "plyless" belt. In other words, a single woven carcass of the desired thickness is employed. It is impregnated with the plastic and the covers applied in the same operation. Covers are the same thickness on both sides and either may be used as the carrying side. One of the first users reports not only practically complete resistance to ignition but also high resistance to cutting, gouging, edge wear, tearing out of splices and other mechanical damage.

An additional advantage of the fire-resistant belt is elimination of the need for

Better Track For Better Haulage

GENERALLY ACCEPTED STANDARDS for good main-line track include 70- to 90-lb rail on heavy treated ties laid in crushed slag, gravel or cinder ballast. The importance of treated ties is shown by one study indicating total tie costs for 1 mi of track for 20 yr as follows: treated ties, $10,600; untreated ties, $34,000.

Welding has come sharply to the fore as a means of joining rails, with steel arc the most widely employed. Recently a new type of aluminum joint, featuring extreme simplicity in application, has been making gains, however. Curves should have a radius of 300 to 500 ft and should be superelevated. Turnouts should not be less than Nos. 5 to 8. Trolley wire should be hung at a uniform height above the rail and aligned with it at the proper distance outside. Shoe-type collectors should be used where feasible, especially on heavy-duty locomotives, and the trolley wire should be adequately lubricated at the proper time intervals for low maintenance and efficient current collection.

Throws and switch-position indicators are essential for safe, smooth main-line haulage, while alloy frogs and proper guarding keep down maintenance and reduce derailments. Automatic switch-throwers and remotely actuated derails save labor and promote safety.

DOUBLE TRACK OR SINGLE?—Most authorities agree that double track is for the big mines, though they split on what is "big." Advantages of double tracking include complete separation and no interference between empty and loaded haulage. Also, since waiting at sidetracks and passing tracks is eliminated, fewer cars and locomotives are required. Furthermore, one track usually always is available and therefore production seldom if ever is completely interrupted. In addition, some mining men point out, double tracking where grades are heavy makes it unnecessary to use a tail locomotive, which might otherwise be considered desirable. Also, it permits installing spring-type derails on upgrades.

Almost the equivalent of double tracking can be attained by proper location of properly designed passing tracks.

Use of locomotives on both ends of trips may have an advantage other than safety. At one mine this practice also makes it unnecessary to run locomotives around trips, either at the panels or at the main dump (drop-bottom cars). Sections are equipped with looped loading tracks and hydraulic car spotters. The haulage crews, one for each of the two locomotives, change trips at the loading points.

DRAINAGE—Mud and water can reduce the capacity of a haulage system as much as one-third or more. Proper ditching is a major answer to keeping haulage roads dry. If gravity disposal is impossible, sumps should be constructed to receive the water and facilitate disposal by pumping. The importance certain mines ascribe to dry haulage roads is attested by a program of building cisterns in crosscuts at strategic points and equipping these with automatically controlled pumps discharging to an outside line.

GRADING—Eliminating humps and hollows not only makes for smoother, safer haulage but also can result in a significant saving in number of locomotives and crews necessary for a given tonnage. If possible, sustained grades against the loads of over 1¼ or 1½% should be avoided. If averages higher than that cannot be avoided, then it is even more essential to knock off peaks.

CONSTRUCTION—Real money can be saved by mechanizing track construction, starting with loading to handle rock. In some instances, it may be possible to do brushing with a continuous mover to achieve the desired grade. And in the final operations, special ballast cars and mechanical tampers cut labor requirements substantially. In one instance, two men using the machine, align and tamp over 400 ft of track a day, compared to 100 ft by five men using hand tools. Special cars distribute ballast at this property, receiving it through a borehole from the surface.

CLEANING—Smoother, faster haulage, less track deterioration and greater safety are the major reasons for emphasis on clean track. Track-cleaning machines naturally reduce the cost to a minimum, while cars in good condition reduce spillage and stretch out the interval between cleaning. In many instances, a considerable tonnage of good coal is reclaimed in the cleaning process, which might well be credited against cleaning cost. Some mines, as a matter of fact, figure they are well ahead of the game by salvaging coal off the track.

LIGHTING—Safety, speed of operation and maintenance all are facilitated by good lighting of haulage roads. The latest types of units are fluorescent tubes, which provide a significant increase in light output for the same current. For a discussion of fluorescent lighting in working sections, and of incandescent lighting along haulage roads, see *Coal Age*, February, 1956, p 84.

Incandescent lamps were the original light source, with the usual spacing as 75 to 100 ft. With the usual wattage of lamps, this normally is sufficient to comply with the rule that there should be no dark spots between lamps. Glare elimination requires proper location, and if necessary, shielding. Mounting lamps along one rib, rather than in the center, may help in glare reduction.

HAULAGE HELPS—New ideas for speeding haulage and reducing maintenance include railwashers on locomotives, flange oilers, defective-wheel and bent-axle detectors, etc.

a neutral-air opening or a separate split, thus approximately halving the number of stoppings required in a beltway.

ELECTRICAL PROTECTION—Suggestions for electrical control and protection include:

1. Connecting each drive to the line through a stepped resistance.
2. Sequence starting, outby drive first, with proper time delay for each subsequent drive.
3. Automatic stopping of all inby conveyors or elevators if any belt should stop for any reason. The usual device is a centrifugal switch.
4. Interlocking conveyors or elevators feeding to a belt to prevent feeding onto one already full loaded. Devices include finger- or paddle-actuated switches, as well as the wheel-actuated devices described elsewhere in this section.
5. Providing overload or pileup protection at belt transfers, using paddles or other devices to actuate switches and shut down the inby drive. These switches should be of the momentary-contact-type so that the inby conveyor will start again when the overload is cleared ready to run coal again.
6. Providing a means of stopping the conveyor anywhere along its length to permit the beltman or any man riding to stop the belt at any time. Continuous pullcord-type controls fastened to the roof also provide protection against falls.
7. Providing drive-pulley slippage control to stop the unit as soon as slippage occurs. A centrifugal switch with pulley riding on the belt, or a centrifugal switch driven by a chain from the bend or snub pulley are two possible devices. A third is a differential control with two pulleys, one riding

the belt and the other the drive pulley so that when one gets out of step the drive is stopped.

BELT CLEANING—A number of devices, each more or less satisfactory, have been developed for cleaning belts before they go onto the return idlers. One is a length of piano wire mounted under the head pulley and almost touching the belt (*Coal Age*, November, 1952, p 89). A recent development is a spring-tensioned rubber blade (*Coal Age*, January, 1959, p 127).

DETECTING BELT TEARS—One of the few practicable methods of detecting major tears in operating belts has been developed at a middle western mine (*Coal Age*, January, 1956, p 88). It consists of a horizontal rod 2 in front of the head pulley. When struck by a torn flap thrown out from the belt by centrifugal force, the rod is knocked down to open an electrical switch and stop the belt until it receives attention.

Hoisting

Use slope belts where possible and consider special high-strength conveyor belts for long-length slopes and high lifts to cut down number of drives and transfers.

Make shaft hoisting and auxiliary operations as nearly automatic as possible.

IN THE ABSENCE of special circumstances, the belt slope is the usual coal hoisting facility installed today. Low operating labor and low maintenance are the major reasons, while improvements in belt design, including rayon, nylon and steel-cord tension elements, have made it possible to install single belt runs up to 3,000 ft or more in hoisting, thus raising the vertical lift to more than 800 ft.

A recent addition to belts for hoisting on the North American continent is the cable belt (*Coal Age*, September, 1958, p 106). This initial installation is providing the expected advantages, including lower operating and maintenance costs.

Belts also work equally well in lowering coal where the terrain permits their installation at inclinations of under approximately 20 deg. Other facilities for lowering include monitors and rope-and-button conveyors and so on.

FEEDING TO BELTS—Any of the standard types of dumps may be employed in transferring coal from mine cars to the belt, unless bottom-dump cars are employed. If so a necessary intermediary is a hopper or bin. Where belts are used for main-line haulage, boomed shuttle belts are used to lay the coal down in a longer and therefore larger-capacity bin. Short transfer and speedup belts also are used between hoppers and slope belts to take the shock and protect the slope unit from some of the wear and tear. Magnetic tramp-iron-detection equipment on either the speedup or main slope belt stops the equipment and permits removal of metal that might result in damage.

Shaft Hoisting

The skip hoist usually raises the equivalent of 2 or 3 cars each trip and thus normally can operate more slowly, with lower acceleration peaks. Where self-dumping cages are employed, fabricating them of high-strength alloys or aluminum reduces dead weight and consequently improves the hoisting operation.

As with all other mining operations, economy in hoisting is a matter of equipment and controls to conserve manpower. Now, any type of vertical hoist-skip, self-dumping or overturning cage, and platform—can be made completely automatic, including caging and, with platform equipment, decaging. Even if complete automatic operation is not desired, automatic cagers, tripmakers and the like speed up the hoisting process and save labor.

Handling Men

Keep travel distance short by building new man-and-materials portals at the necessary intervals.

Use transportation equipment and methods that provide the maximum in safety with the maximum in time-saving.

PROPER PORTAL LOCATION or relocation provides, among other things, an opportunity for streamlining the handling of men and also attaining maximum convenience and comfort in changing in and out. A collateral benefit is an up-to-date field supply setup, with possibly also a field maintenance shop that is much nearer the active workings.

KEY OBJECTIVES—Aside from supplies and maintenance, key objectives in portal design include:

Ample all-weather parking.

Good wash and change facilities.

Good lamphandling facilities.

Protected facilities for men waiting to board trips—from weather and electricity particularly.

Adequate first-aid facilities.

Hoisting

Where men are handled through separate man-and-material shafts, either at the main opening or back at field portals, usual practice today is to install pushbutton-operated elevator-type equipment in capacities up to 50 men, which reduces the total time required to put a crew into the mine car or bring it out. The cage may also be adapted to handling heavy supply items, though the tendency is to use the regular opening for this purpose, especially drift or slope.

Drilled shafts with automatic hoists may provide a lower-cost answer to the problem of putting portals close to the working areas. At one mine (*Coal Age*, November, 1955, p 60) a 72-in drilled shaft was fitted with a double-deck circular cage with a capacity of 10 men per deck. Pushbuttons control the automatic hoist. Hoisting distance is 487 ft. Travel time was cut 45 min with a resultant rise in output.

SLOPE CARS—Where men enter through slopes, some mines, where the regular equipment cannot be employed, provide special slope cars for that part of the trip. If single cars are employed, the trend today is to equip them with magnetic track brakes actuated by an overspeed device or by a push-button under the control of a foreman or trip-rider. Where several cars are put together in a trip, they can be preceded by a pilot car with magnetic-brake equipment. If men walk the slope, a "ski-tow" installation, which gives them a one-handed pull, is a major help in negotiating stairs in the "up" direction.

Car Transportation

Where height is sufficient, the covered mantrip car is practically standard for transporting men by rail. In addition to cars pulled by locomotives self-powered units are available in capacities up to full section crews, making it unnecessary to detach locomotives for this service. Where several individual cars are in service, dispatching and block signals are essential to prevent collisions. At trackless mines, corresponding equipment on rubber, battery-powered, is available.

Low coal makes it more difficult to cover cars that go into areas where top is not taken. Flat-bed rail cars with rubber mats can be used, with the men lying crossways. Self-propelled types include one in which the men lie down with knees up to each end (*Coal Age*, March, 1954, p 190). Capacity is sufficient for a section crew of 11 men. Height over the rails is 24 in. As in thick coal, equivalent equipment is available on rubber for thin-coal operations.

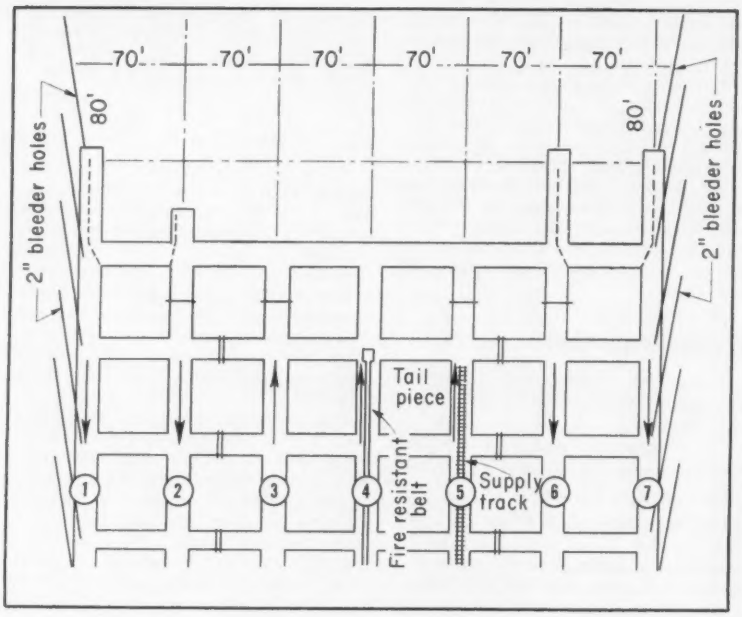
In addition to regular mantrip cars, a variety of rail and rubber-mounted cars may be employed to save time and promote efficiency in transporting mechanics, electricians and repairmen, as well as officials. The list includes even small one-man three-wheeled "trikes" for trackless operations. Types for mechanics, electricians and repairmen include tool and supply boxes and wells or decks for carrying heavy items.

Belt Transportation

Under proper safeguards, movement of men on belts has proved both safe and efficient. The major safeguards include ample vertical clearance all the way, extra clearance at points where men get on and especially where they get off, equipment to reduce speed to approximately 200 to 250 fpm, and an emergency stop cord or stop system all along the belt so that any man can stop it at any time. The system should be designed so that the belt cannot be restarted without a check to see that no hazard is involved. A space of at least 6 ft must be maintained between each man on a belt.

Belts may be reversed to take men in, and a few mines have designed mainline systems with that in view. In going in, men necessarily must get off and change if more than one belt is in service. There also should be a rigid rule that men get off and change coming out as well. Ample clearance and smooth unencumbered footing should be provided at all loading and unloading points. Finally, in addition to all other steps, no movement of men on belts should be permitted except while a responsible supervisor is present.

SLOPE BELTS—In addition to level movement special low-speed low-cost belts now are employed in hoisting men up slopes (*Coal Age*, September, 1958, p 130).



DEVELOPMENT PLAN, using continuous mining machines, includes provisions for advance drillholes in solid-coal areas to drain methane evenly.

Ventilating Today's Coal Mines

What is needed . . .

1. Sufficient air at the immediate face to effectively dilute methane and to serve as an agent in controlling dust
2. Providing this air at lowest possible cost, consistent with safety and utility

How to get what is needed . . .

1. At an existing mine, complete an accurate survey of present ventilating performance; at a new mine, consider later ventilation needs in early planning
2. Select modern fans and air-coursing equipment that can grow with the mine as the need develops
3. Keep a checkrein on costs by pressing for lower power requirements—particularly, preventing fugitive air
4. Take steps to reduce need for regulation, where economically possible
5. For safety reasons, consider bleeder-entry plans, study auxiliary face ventilation possibilities

Trends in ventilation . . .

1. Drilling of large-diameter shafts for air openings and escapeways will become more prevalent because of the economies now showing up in this method of shaft sinking
2. Plans for development of permanent barricades as emergency havens for face crews will be refined and executed
3. Research on ways and means to provide auxiliary ventilation in continuous-mining working places will pay off in the years immediately ahead

Where to Find It . .

The Fundamentals ..... p 250
Reconnoitering ..... p 251
Fans and Supplies ..... p 251
Controlling Costs ..... p 252
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VENTILATING A MINE is somewhat analogous to the pumping of liquids. In both cases, a pressure system is involved, employing (1) a power-consuming device somewhere in the circuit to create a pressure differential, (2) closed conduit to carry the pressurized fluid and (3) a discharge to the atmosphere. Safe, economical ventilation consists of taking maximum advantage of the pressure differential to scour all active openings with fresh air, then to reject the refuse of the process through the return airways into the atmosphere, avoiding the use of excessive power to project the discharge stream into the atmosphere.

Achieving maximum advantage of the pressure differential is the core of the ventilation engineer's job. It is also a prime job requirement of all legally certified mine officials. Stripped to its essentials, the job of ventilating a coal mine involves the following:

1. Employ an efficient fan that will provide a pressure difference of such magnitude that the desired quantity of air will flow against the resistance offered by the airways.

2. Keep this resistance to a minimum —by providing sufficient airway area—to minimize the amount of power required at the fan to create the pressure difference.

3. Split the air current to insure safer ventilation of individual areas of the mine.

4. Introduce regulation as needed in the low-resistance splits to balance the system.

Coursing the air within the splits requires strict supervision and iron-clad discipline, especially in continuous-mining sections. Furthermore, a management decision will have to be made as to whether worked-out areas are to be sealed or ventilated. A decision to ventilate these areas means that a system of bleeder openings must be designed. Then the entire circuit must be patrolled and maintained because a coalmine ventilation system grows longer and more complex every working day.

The Fundamentals

Be sure of an adequate supply of air at every working face, then use the power bill as a gage to measure ventilating efficiency.

MOST of the effort in designing or updating ventilation systems is put forth with

one eye on the power bill, since the goal is to provide adequate ventilation at minimum power. And following back from the power bill, it is seen that keeping the velocity of the air within reasonable limits is a basic requirement because (1) power varies as the cube of the velocity; (2) pressure varies as the square of the velocity, and (3) quantity varies directly with velocity.

Improvements in varying degree may be achieved by cleaning up airways to reduce resistance, sealing leakage, splitting and regulating in the most efficient manner, shortening the distance of air travel through the use of new airshafts and other such steps.

Even at mines where the ventilating duty is governed by the amount of methane made in the workings and the necessity of diluting it and sweeping it away, there is the possibility of draining off some of the methane through boreholes tapping the solid coal ahead of the mining.

Reconnoitering

Proceed on the basis of knowledge gained through a comprehensive ventilation survey of the mine workings.

WHEN THE JOB at hand consists of planning a ventilation system for a new mine, the officials in charge of the work should avail themselves of all information and experience offered by others who have conducted operations in the same seam or area. Helpful leads and precautions will be brought to light that will result in the highest degree of modernization in the equipment and plans for ventilating the new property.

This search for available experience and information is particularly important if the new mine is to employ continuous-mining methods. Steps can be taken from the day ground is broken to insure that sufficient air is made available to working sections to effectively serve continuous-mining faces. This is one aspect of reconnoitering the situation in approaching a ventilation problem.

More often, however, the engineer or mine official is required to improve an existing system in order to reduce costs or increase ventilating efficiency at the face. The first order of business in modernizing an existing layout should be the completion of an accurate velocity-pressure survey. This reconnaissance will identify regions of high resistance or excessive velocity and will help determine the extent of wasteful leakage and the locations of leaky control devices.

Some companies have found it advantageous to feed data from ventilation surveys to electric-analog network analyzers to get a picture of air-flow distribution without pursuing laborious calculations. The Bureau of Mines operates one of these units.

Fans and Supplies

Modern fans are designed to "grow with the mine."

Today's materials for conducting air or building brattices are of high quality. Maximum efficiency depends upon quality of workmanship in using them.

MODERN FANS, with few alterations in mine conditions, often can effect substantial reductions in power consumption, partly because of the inherently higher efficiency of the new units and partly because the new fans can be more closely matched to mine haracteristics. Quick blade adjustment makes it relatively easy to keep mine and fan more closely paired.

Better design in ventilating materials is not confined to fans alone. Also available are improved curtain materials, including treated cloth and neoprene-coated types. The latest item in this line is a plastic check curtain with a transparent center panel to aid shuttle-car operators.

REUSABLE MATERIALS—New materials for stoppings include telescoping metal sections and sheet plywood. Noteworthy features in these are rapid installation for savings in labor and full reclamation for savings in supply costs.

Not to be overlooked in the list of reusable materials are cinder blocks. However, there are vast differences in the permeability of cinder block, both among the products of different manufacturers and among the lots of the same manufacturer. Giving more attention to specifications in the purchase of blocks and to testing the blocks upon delivery will result in reduced leakage through stoppings.

Prefabricated materials, corrugated pipe sections for example, may be used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful aircurrent controls. As a result of these developments, overcast is no longer a bad word in ventilation.

The main point to remember in constructing overcasts is that causing the air to pass through abrupt changes in direction or area results in excessive losses in useful ventilating pressure due to turbulence and shock. The cross-sectional area of the overcast may be less than that of the approach without resulting in appreciable losses, if the approach is gradually narrowed down to the area of the overcast. The object is to simulate, as near as possible, a true venturi section.

AUXILIARIES—Auxiliary air movers, including fans and portable evase units for the control of compressed air, may be of some help when properly used with the approval of regulatory agencies. Better ventilation in continuous mining has been achieved through the use of auxiliary exhaust fans and flexible tubing. Installed with safeguards against recirculation, the fan provides adequate air at a velocity which is sufficient to remove dusts to an appreciable degree, improve visibility at the face and dissipate the heat generated by the face equipment. Improvement of these fans is a matter now receiving intensive study in the industry.

At least one installation of an inertial, wet-type dust collector has been made on a boring type miner to perform the combined duty of passing air across the immediate face and precipitating dust. Others are seeking practical ways to mount auxiliary blowers, exhausters or diffusers directly on the mining machines in order to provide a source of air that moves up as the miner advances.

In anthracite, trumpet-shaped air movers, connected to compressed-air lines, have been used to direct air to the faces of steeply-pitching places beyond the last open crosscut.

Doors are a necessity at some point in every system. Recent developments in these include a compressed-air-powered automatic door for heavily-travelled haulageways. The

Field Reports

Bleeder Shafts—Core drilling of large boreholes is most economical way of sinking ventilating shafts in Pocahontas No. 4 seam. *Coal Age*, June, 1957, p 99.

Weather Effects—Passage of fronts may affect methane emissions and mine-moisture conditions. *Coal Age*, February, 1958, p 164.

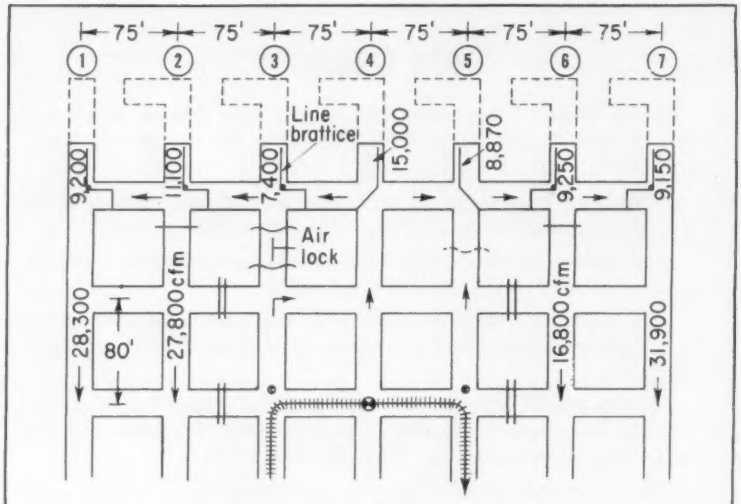
Shaft-Sinking—Blasthole shaft-sinking shows significant cost and safety advantages. *Coal Age*, June, 1958, p 106.

Air Distribution—Studies of resulting air distribution after fan stoppages in multiple-fan systems prevent hazardous conditions. *Coal Age*, August, 1958, p 88.

Multiple-Fan Ventilation—Maximum safety in multiple-fan ventilation requires use of self-closing doors, two-split section ventilation and fan-monitoring systems. *Coal Age*, January, 1959, p 96.

Face Ventilation—Steady emission of methane from working faces, continued bleeding from ribs and float dust are major problems in ventilating continuous-mining faces. Depending upon rate of emission, solution to the problem may require auxiliary fans, tubing and brattice lines. *Coal Age*, February, 1959, p 96.

Diffuser Applications—Eleven steps to safety and efficiency with auxiliary ventilation. *Coal Age*, February, 1960, p 138.



Cycle →				Air split	← Cycle		
1	2	3	4	5	6	7
Drill and cut	Idle	Roofbolt	Load coal	Shoot	Shot	Shot
Shoot	Drill and cut	Idle	Roofbolt	Shot	Shot	Load coal
Shot	Shoot	Drill and cut	Idle	Shot	Load coal	Roofbolt
Shot	Shot	Shoot	Drill and cut	Load coal	Roofbolt	Idle
Load coal	Shot	Shot	Shoot	Roofbolt	Idle	Drill and cut
Roofbolt	Load coal	Shot	Shot	Idle	Drill and cut	Shoot
Idle	Roofbolt	Load coal	Shot	Drill and cut	Shoot	Shot

IN CONVENTIONAL MINING better face ventilation is achieved by splitting two ways at the face and cycling to avoid blasting fumes.

operating controls are actuated through the trolly system and all mechanical linkage and the operating cylinder are suspended from the mine roof and attached to the top of the door. None of the parts is exposed to wet bottom conditions nor to damage from possible derailments. Some mines now swing their conventional doors from steel jacks to make possible faster relocations.

Controlling Costs

Skill and imagination in applying the well-known fundamentals in particular conditions lead to lowest costs for ventilation.

THE ADVANTAGES to be found in modern ventilating equipment may be fully realized or they may remain undeveloped, depending upon the degree of care and skill employed in conducting the air through the workings. Excessive leakage and insufficient airway area are especially wasteful, no matter how efficient the fan.

Fugitive air is the most expensive luxury in today's coal mines—and the most dispensable. Surveys of some mines show that up to 80% of the air moving through the fan never reaches the working faces. It leaks through poor stoppings, around doors and so on, back into the returns without moving anywhere near the active sections. Even in mines where ventilation is given more serious consideration leakage may short-circuit up to 30% and more of the incoming air supply.

PREVENT LEAKAGE—The penalties in fugitive air, measured in terms of wasted power, are shocking in some instances. Since a certain quantity at the face is mandatory, fan speed must be increased to insure that effective face ventilation, over and above leakage, will meet these legal requirements. And power consumption increases as the cube while the increase velocity contributes to still more leakage.

Sealing at points of excessive leakage is one way to lick the problem. As previously mentioned, cinder blocks differ in permeability, and it has been found that cinder-block stoppings can be made more airtight by applying a coat of plaster. A coat of paint over the plaster provides a still tighter seal. One company has sealed hundreds of stoppings by mixing portland cement with the slurry in a wet rockduster, then applying the mixture to the stoppings in the conventional manner of wet rockdusting.

Another way to reduce leakage is to look for ways to achieve one-way flow, thus eliminating leakage opportunities by doing away with side-by-side intakes and returns separated by porous stoppings and other leaky control devices. Air-shafts or openings to the outcrop may be used as new fan locations or additional intake openings to get the one-way flow. Even in deep cover, the cost of a new shaft may be more than recovered in a reasonable time in power savings alone.

Furthermore, the cost of sinking a shaft is not what it used to be. In one instance (*Coal Age*, June, 1958, p 106), a shaft was sunk by drilling a circle of large-diameter holes with an overburden drill, then shooting the hard core against the relief provided by the drillholes. The job was quickly done with fewer men and in greater safety.

In another instance (*Coal Age*, November, 1955, p 60), a shaft was sunk using a core drill which cuts a 75-in hole at rates of 4 ft per hr in limestone and 1 ft per hr in sandstone.

In another area where numerous wants and faults occur, it is found that a pressure system is best in ventilating long narrow gassy areas of coal so long as bleeder shafts are provided at the extremities of these coal areas. As soon as the limits of these areas are determined by completion of development work, a bleeder shaft is drilled down to the coal to remove the gas-laden air from the pillaring sections. Loose ground through which the bleeder shaft is to be drilled is consolidated by grouting. Then a 36- to 48-in hole is calyx-drilled to make the bleeder shaft.

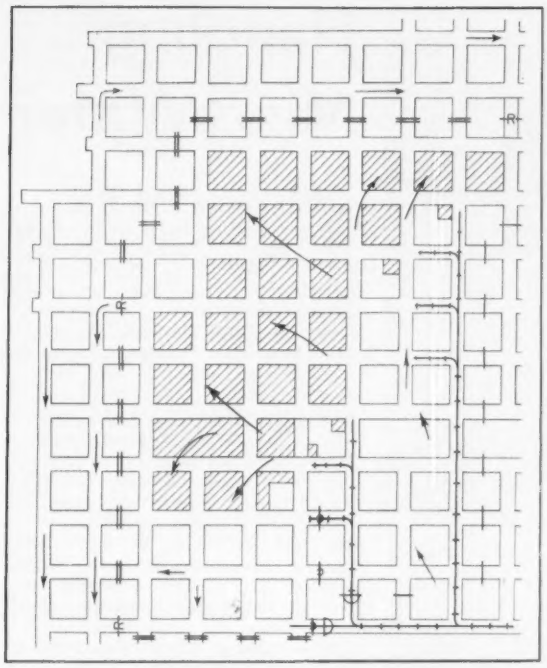
One-way travel contributes to even bigger power savings inasmuch as a change to this system results in increased airway area with former returns now serving as intakes. The upshot is either reduced velocity for the same quantity or higher quantity at the same velocity, a bonus either way.

Coursing the Air

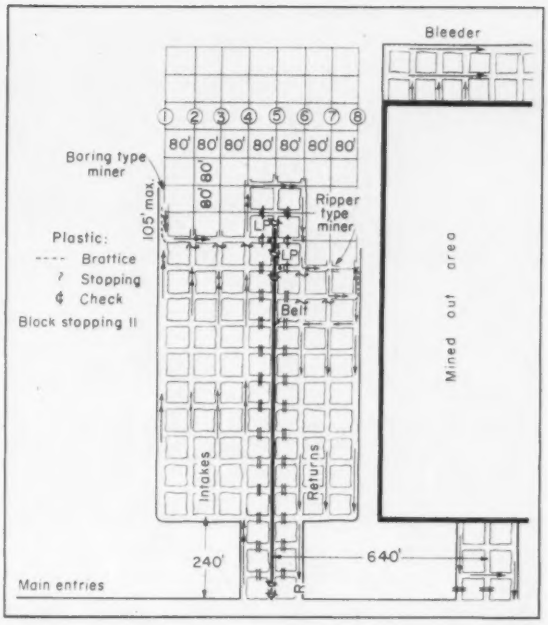
The big problem is conducting an effective volume of air from the last open breakthrough to the face, particularly in continuous-mining places.

INCREASED SAFETY is by all odds the reason for splitting air currents underground. An explosion in a mine ventilated by one continuous current of air could affect the entire mine, while in a mine served by several splits the effects would be more confined.

There are other good reasons for splitting. The mine resistance is reduced, power is



REGULATORS in active pillar section cause air to flow across pillar line. Line brattice can be added to increase flow along pillar line. Bleeder openings are examined daily by certified officials as an added control feature.



MULTIPLE-ENTRY section is advanced and retreated by two continuous miners, including driving bleeder-entry hookup as last phase of development. Line curtains and checks are made of airtight plastic sheeting.

conserved, and better local control of the air becomes possible.

The ideal situation, which shows all splits naturally balanced in resistance, is seldom achieved in actual practice, since in some splits development work will predominate and, in others, room work. Some regulation becomes necessary to raise the resistance of all other splits to that of the longest or high-resistance split. Up to a point regulation is helpful, but it can become wasteful.

It pays to investigate the possibility of using an auxiliary fan to serve the high-resistance split alone, thus eliminating any need for adding resistance in the other splits. The benefits are reduced power requirements and lower pressure differentials on stoppings outby the booster fan.

Sometimes a well-planned cleanup in the free split may result in the passage of more air, also reducing the need for added regulation in all other splits. Some companies have found a ventilation bonanza by rehabilitating old airways with roofbolt support in place of timbers. The resulting increased area and decreased resistance work together in compounding the benefits.

FACE VENTILATION — Recent studies indicate that getting a sufficient volume of air up to the face crosscut is not the big problem. In continuous mining the big problem is to conduct this available air across the "teeth" of the machine, right at the immediate face. Even a well-constructed line curtain may leak most of the intake air before it comes anywhere near the face. If line curtains are used, their installation must be closely supervised in every instance.

Elimination of doors and checks across shuttle-car roadways is accomplished at one mine by diverting intake air around dumping points in the belt entry. The system is based upon 3-heading entries in room panels, with the panel belt in the center heading. Two well-constructed checks are built across the belt heading on either side of the shuttle-car dumping point and a stopping is erected in the entry breakthrough between these two checks and on the side of the belt opposite the dumping point. Intake air is thus diverted around the dumping point to the outer heading. It returns to the center heading beyond the dumping point.

Ventilating for Safety

The speed of advance in modern coal mining requires that ventilating systems be constantly reevaluated.

Monitoring of outlying fan stations is becoming increasingly important. The monitoring must be done automatically for maximum economy.

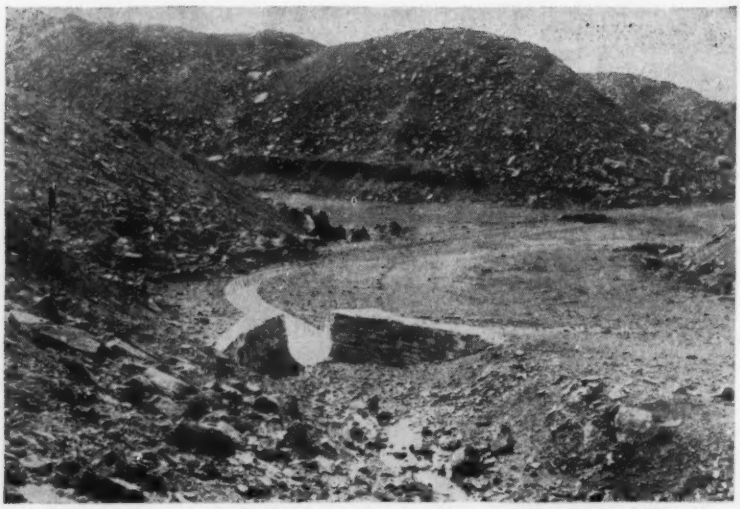
ACCUMULATIONS of gas in worked-out areas are especially hazardous in today's coal mines because of the rapid extraction in highly mechanized methods and the consequent increase in the rate of methane emission. The worked-out area increases rapidly, close by the active places where a number of electric-powered machines are concentrated and the entire crew is assembled.

In conditions like these, more and more operators are including bleeders in their mine projections to ring gob areas with openings through which air passing through the gob may be conducted directly to the returns. In some instances, air from the worked-out areas passes into the returns through regulators which control the quantity of air passing through the gob as well as insuring adequate air and positive pressure along the pillar line. Properly maintained bleeder headings practically eliminate the possibility of gas migration during periods of low pressure.

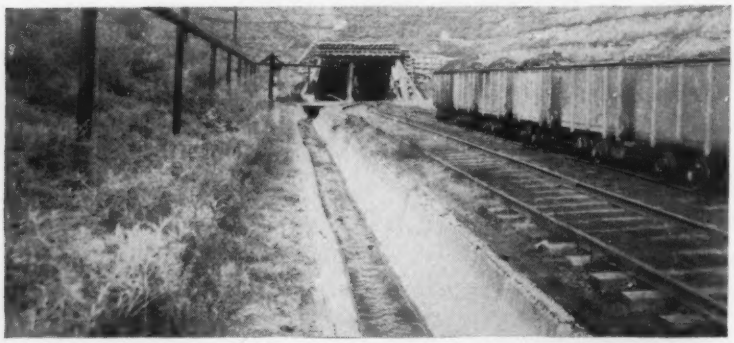
Along similar lines, it is advantageous in gassy conditions to begin recovery of room panels by driving a pair of line rooms along the outby limit of the panels parallel to the mains. Such rooms serve as an extra pair of low-cost airways, and the outby room may be preserved in the bleeder network after the panel has been robbed.

Also in the field of safety are designs for automatic methane detectors which will interrupt line power to electrified face machines when methane content rises to a predetermined value. And more and more mines employing multiple fans are turning to the use of automatic monitoring systems to provide centralized information on fan outages. These systems of fan control are coupled with definite rules for inspection of fan stations when the monitoring system indicates an outage. Self-closing doors associated with each fan in multiple-fan systems prevent reversal of airflow which would further complicate the situation. A wise practice at such mines is to take advantage of idle days and vacation periods to study the changes in distribution of air as each fan is shut down in turn.

Handling Mine Water



WELL-CONSTRUCTED flumes and ditches should be used to carry surface water over underground workings, eliminating a rehandling problem.



GRAVITY FLOW from portals, through outcrop openings or to centralized sumps must be utilized wherever possible to minimize power requirements.

The Approach

Keep the water out, if possible
Look for gravity-flow opportunities
Then design for low-cost pumping

Achieving Results

Use boreholes to shorten pumping distances or to eliminate pumping altogether
Plans for peak or peakless pumping depend upon cycle of production operations
Use modern labor-saving materials and supplies in constructing mine-drainage pipelines
Take steps to minimize acid discharge and prevent pipeline corrosion

Trends in Handling Mine Water

Regional pumping stations, maintained by more than one company, may lead to reduced costs through less rehandling of water
Fire-fighting systems will be based upon drainage lines in which flow is reversible
New chemical grouting materials will aid in controlling water during shaft-sinking operations

Where to Find It . . .

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DETAILED PLANS for handling water will have to be made at most mines. Procedures for getting the job done, in order of preference, are (1) keep the water out of the mine, (2) return it to the outside by gravity flow if it does get into the workings and (3) design for high-efficiency pumping through the straightest, shortest pipelines it is possible to achieve, using boreholes to the surface or outcrop wherever this opportunity presents itself.

Mine drainage is somewhat like mine ventilation, in this respect:

The most efficient fan in the world cannot provide low-cost ventilation if the airways present high resistance if excessive leakage is permitted or if expansion of the workings outruns the plans for extending ventilation. Similarly inherently high efficiency in a pump can be diluted if suction and discharge lines are poorly designed and installed, if excessive labor is required to maintain the lines or if pump operation requires attendance.

However, first order of business in drainage is to keep the water out.

Diversion And Gravity Flow

Compare the cost of constructing a long-life diversion flume against the cost of power for raising the same amount of water from the workings over the life of the flume.

DIVERSION DITCHES around openings, sealed stream beds at troublesome points, grouting underground to seal off stream channels, new channels if necessary and well-constructed dams are possible controls which may be used to keep water out of underground workings. Flumes make it possible to conduct surface water across previous areas of mining properties and dump it back into natural drainage channels on the other side.

It is neither possible nor practicable in most instances to keep out all water. Some provisions must be made for handling underground inflow.

Other things being equal, it may be possible to lay out the mine so that workings advance to the rise, giving an assist to haulage as well as to drainage.

USING BOREHOLES — In other instances, it may be possible to drill boreholes

to the cropline or into a sump area to permit gravity flow by the most direct path. At one mine, where some places necessarily are advanced to the dip, 2-in boreholes are drilled at the face through 60 ft bottom rock to old workings in the seam below. The old workings are open to the outcrop, facilitating gravity drainage of both seams.

SUMPS IN DIP WORKINGS—At a new mine, where the seam dips 8%, room panels are worked to the dip from strike entries on advance and up the pitch on retreat. The idea is that the dip workings are finished before extensive areas have been opened up, and the dip rooms will serve as sumps for the uphill workings.

When all's said and done, however, chances are some pumping will have to be done. But handling water with today's equipment is a far cry from the difficult job it was in the past. Today's advantages include efficient pumps or any type of duty, electric power in place of steam, automatic controls to cut the cost of operation and materials designed for long life at reasonable cost.

Selecting Pumps

Don't specify a pump. Specify the conditions under which the pump will have to work, then discuss the details with a pump supplier.

THE TYPE OF PUMP selected depends entirely upon the pumping job to be done. In two out of three of today's mine-drainage applications, centrifugals of one type or another will be found, but each of these is practically a tailor-made unit.

SPECIFYING CONDITIONS — The pumping job at one mine may be entirely different from that of its nearest neighboring mine with regard to such factors as volume, total head and water acidity. The best bet, therefore, is to work closely with a pump manufacturer in determining the one best pump for the application.

The final selection will depend upon whether the service is to be continuous or intermittent, whether AC or DC power is to be used, how much water is to be handled, how much variation may be expected in suction and discharge heads and so on.

SPECIAL CONSIDERATIONS — If the water is free of solids, a multistage centrifugal unit to work against a high head may be used, but if solids are present a number of single-stage units in series should be used because solids ruin multistage pumps. Thus pump selection becomes an exercise in balancing a number of sometimes-conflicting factors. Complete foreknowledge of the conditions is vital to successful selection.

Also important in selection is a decision as to whether the total pumping capacity should be provided in a single unit or in twins, with the latter choice getting the nod in most recent installations because of the resulting flexibility.

Foresight should be used in arranging the pumping schedule to dovetail with operations. For example, at a three-shift mine it may be desirable to provide "peakless" pumping to spread the pumping load over the entire day, while at a two-shift mine it might be better to provide enough capacity to handle all the water on the off shift when demands for production power are at a minimum. In either case, sump capacity will have to be planned and provided to suit the system finally selected.

And in certain special cases, it would be well to investigate the possibility of "community" systems among several mines or companies.

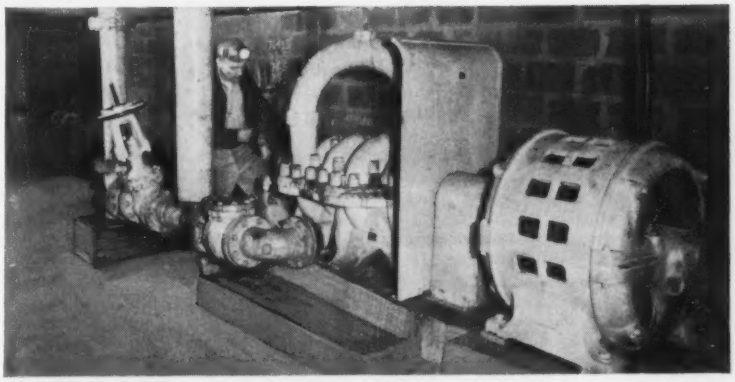
Field Reports

Dual-Purpose Borehole—A 4-in water line is installed in the same borehole with four 2-in pipes for power cables. *Coal Age*, June, 1957, p 70.

Neutralization—Water-powered device facilitates addition of hydrated lime to run-off stream. *Coal Age*, March, 1958, p 148.

Aluminum Tubing—Rolled grooves at joints permit faster assembly of thin-walled pipelines. *Coal Age*, April, 1958, p 110.

Acid Drainage—Demands for clean streams make it necessary for producers to prevent acid formation, insofar as possible. *Coal Age*, April, 1960, p 80.



CAREFULLY SELECTED PUMPS, well-designed pipelines and planned pumping schedules lead to lowest costs where water must be collected and removed.

Planning Pipelines

Use the largest-diameter, straightest pipeline possible for reduced friction, thus lower power costs.

Make some provision for automatic priming to get maximum dependability from the system.

USUALLY THE MAJOR VARIABLE which is amenable to some measure of control is the friction head in the piping itself. The quantity to be pumped is a definite figure and the static head is fairly fixed, but the friction head can be held to a minimum by designing for the largest-diameter, straightest pipeline it is possible to achieve.

Small pipe and numerous fittings and turns will extract a penalty in the form of either higher power requirements or reduced volume of discharge.

In the normal case, pipe of the largest usable diameter will be most economical in the long run.

SYSTEM DESIGN — A well-designed pump installation will show these features:

1. The suction line leads straight into the pump for a length equal to four to six pipe diameters.
2. The suction pipe is one or two sizes larger than the pump nozzle, and it is connected to the pump through an accentric reducer which is properly placed to eliminates suction-line air pockets.
3. The drive motor and pump are in good alignment.
4. The piping is supported so that the pump carries none of the pipe-line weight.
5. Priming auxiliaries, if they are needed, and lubricating facilities are in good working order.

Priming water for one underground pumping station is taken from the dust-allaying spray water system. An antomatic cut-off is provided to disconnect the spray system as soon as the pump takes up its load.

Furthermore, all large drive motors should be equipped with protective devices that will interrupt power in the event the pump fails to pick up its load.

Special Projects

More economical drilling methods lead to greater flexibility in solving water-handling problems.



LIGHTWEIGHT GALVANIZED PIPE is suspended from roof in a system for removing water from a trackless section.



MECHANIZED SUPPLY HANDLING and modern piping provide possibilities for reducing service labor in handling mine water.

Chemical grouting is a definite aid, especially in shaft-sinking through water-bearing strata.

Fitting the pumping system into the overall mining plan is another matter. This is another instance where each setup is somewhat different from any other, as local conditions dictate. An example of how to get the most out of a dollar of drainage cost is demonstrated at one mine where three gravity-fed sumps and three pumping stations remove 3,000 gpm in three stages over a distance of 3 mi. Each station is provided with independent pumping power through a borehole cable. Wood pipe in 8-, 10-, 12- and 16-in diameters is used.

The two main pumps at this property operate on alternate 12-hr cycles thus making a peakless pumping load on the power system. The sumps act as accumulators in making this pumping schedule possible.

DEWATERING—At an anthracite mine the problem was to unwater some workings on the other side of a 200-ft barrier pillar to permit recovery of the pillars in the flooded mine. Broken strata above the workings ruled out the possibility of using a borehole to the surface. The solution was to drill a pair of 12-in horizontal holes from the active mine through the barrier pillar to tap the flooded workings. The borehole lines were connected to a 7,000-gpm 700-hp pump which discharged through 2,300 ft of 18-in asbestos-cement pipe installed in the slope of the active mine.

LARGE-DIAMETER BOREHOLES—At another anthracite property it proved to be more advantageous to drill two 24-in boreholes from the surface to a depth of 537 ft to reach the best natural sump in a worked-out lower vein. Upper veins then could be drained into this sump through smaller boreholes which were drilled at intervals as the workings advanced to keep the pipelines to gathering pumps as short as possible. The two larger boreholes each serve a 4,400-gpm 10-stage pump, driven by a 700-hp 4,000-V AC motor.

Incidentally, both of these anthracite drilling operations were let out on contract to a company that specializes in these projects.

CHEMICAL GROUTING—A new assist in the control of subterranean water is provided in a non-viscous chemical solution that will penetrate any mass through which water flows, then turns into a stiff gel in a controllable period of time. The material is available as a powder, it is dissolved in water at point of use, and catalyst is added to control gelling time.

Lower-Cost Water Handling

Install automatic controls to minimize service-labor costs.

Employ lightweight, reusable pipe with fast-action couplers in lines which must be relocated periodically.

THE SYSTEM must now be operated and maintained with minimum expenditure of service labor. This means that pumps and other drainage equipment must give longer trouble-free service, pipelines must last longer, relocations of pumps and piping must be made in less time, and long runs of piping must be installed in the shortest possible time.

Every manufacturer of drainage supplies designs his equipment to perform one or more of these functions. Here are some examples.

Saving Labor in Pumping—Pump controls ranging from simple float switches to elaborate fully-automatic systems for large stations are available. Modern pumps can be made of special alloys or lined with coatings which increase pump life in handling corrosive waters. One anthracite operator found he could increse the interval between overhauls by painting pump interiors with special insulating varnish, normally used in electrical applications.

Longer Pipe Life—Asbestos-cement, plastics, aluminum alloys, synthetic rubber, special coatings—all these materials in the form of mine pipe have materially increased time-in-service for pipelines. A new offering, now on the market, is a line of grooved pipe fittings, in malleable iron or aluminum up to 12-in diameter, which are lined with polyvinyl-chloride.

Easter Relocation—Fast snap action couplings for use with plain-end pipe now permit fast disassembly and reassembly in a new location of pipelines up to 6 in in diameter. Grooving machines now are available for modifying plain-end pipe to take the faster self-aligning couplings.

Quick Installation of Longer Runs—Long coils of lightweight plastic pipe or long sections of aluminum pipe now can be installed by one or two men, where the same men formerly would be hard-pressed to lay a fraction of this length in the same time.

Clean Streams And Pipelines

Acid-control considerations may have more effect on your pumping schedules than the technical aspects of the matter, such as volumes to be handled, peak periods and so on.

THE PRESSURE on preventing acid mine water and mine-waste solids from entering public waterways is mounting year by year. In designing drainage systems and arriving at pumping schedules, mine operators may have to weight their plans in favor of fast removal of mine water to prevent long contact with sulfuritic materials. In some instances, this may be an overriding consideration in designing for sump and pump capacity.

Faster handling of mine water will also be helpful in delaying the buildup of "yellow boy" in pipelines, and in lessening the corrosive effects of the highly-acid water that would result if the water were allowed to stand in the mine. The end product of this kind of planning will be longer lasting pipelines, which means additional savings in drainage-system labor.

Power Designs for Modern Mining

Design Purpose . . .

An efficient distribution system insuring maximum service and protection of equipment and personnel.

Basic Approach . . .

Sufficient capacity to serve connected load.

Provision for future load growth.

Adequate power-factor correction and voltage regulation for better and cheaper power.

Minimum number of circuits for simplicity.

Maximum protective features for safety and efficiency.

Necessary converting equipment to produce the required kilowatt capacity.

Practice Trends

AC expected to continue to grow because benefits are proving more favorable than first expected.

Transmission voltages being increased. The trend is toward 4,160 V, although a few mines are using 7,200.

As concentration, loads and transmission distances increase, 13,000 V may be expected to enter the picture at some future date.

If diesel-powered locomotives are permitted in the mines in the future it will be possible to eliminate DC entirely. This would tend to step up the conversion rate.

Increased use of AC power at the face may make it necessary for state and federal bureaus to rewrite the electrical code for coal mining.

THE ELECTRICITY required to produce a ton of coal today is approximately 11 kwhr compared to 8.5 kwhr 4 yr ago. Power cost per ton of coal has increased from approximately 12c to about 15c during the same period. These figures represent substantial increases in power consumption and cost. They reflect not only the continued trend to mechanical mining, but to the use of higher-capacity mining equipment as well. The growing list of modern preparation plants with their ever-increasing power loads also have contributed to the rising rate of power consumption and cost.

Power consumption and cost will continue to increase. In view of this fact it is essential that coal companies plan, install and utilize purchased power to achieve maximum service.

Sections in the text beginning with numbers and printed in boldface type are taken from USBM Bulletin 514, entitled American Standard Safety Code for Installing and Using Electrical Equipment in and about the Mines. The provisions of this code are minimum provisions and are designed to minimize hazards to life and property in and about coal mines. They indicate the steps necessary in the selection, installation, operation, inspection and maintenance of electrical equipment and circuits to obtain proper safeguards in reducing electric shock, fire, explosion and other hazards.

AC Power Systems

Design the power system, surface and underground, to achieve safer, more dependable equipment performance.

ELECTRIC POWER SYSTEMS, whether AC or DC, should be planned to give maximum service. But what is maximum service and how do you get it? The approach to power-system designing necessitates giving several basic factors all the consideration possible to achieve maximum service. These factors include, among other things, the following:

1. Safety.
2. Reliability.
3. Cost.
4. Voltage quality.
5. Ease of maintenance.
6. Flexibility.

2.1.11 ELECTRIC SYSTEM—Electric system means all electric equipment and circuits that pertain to the operation of the mine and are under the control of the mine officials.

SAFETY—Safety features applied to power systems are for the protection of personnel and equipment and also to limit failures which result in lost production time. No one phase of safety should be slighted or overlooked. The outstanding factors of safety standards include:

1. Use of quality electrical components.
2. Simplicity of design.
3. Provisions for adequate short-circuit interrupting facilities properly coordinated to insure selective removal of faulty components.
4. Use of metal enclosures for components.
5. Adequate interlocking features for the overall system.
6. Effective grounding for the system and equipment.
7. Good installation practices and proper maintenance.

RELIABILITY—Simplicity of design and the use of adequate high-quality electrical equipment will insure service reliability. The degree of reliability should be consistent with overall economics. And modern-day mining demands reliability because the size of equipment has increased and higher productivity per unit is required to maintain coal's position in today's market. A loss of 8 to 11 tons of coal for each minute of downtime is not uncommon. Consequently, the aim with regard to reliability vs economics should be to achieve 100% reliability. Initial cost may run slightly higher in attempting to achieve this goal but in the long pull reliability will pay off.

COST—Whether a power system is being updated or a new one installed it is better to consider more than one plan. This will aid in providing cost comparisons for selecting a system that meets individual power requirements at the lowest cost.

VOLTAGE — Careful consideration should be given to mining methods and conditions, maximum distance voltage is to be transmitted, and whether the overall mine system will be AC or DC. Normally, the one-step system is employed, with either 2,400 or 4,160 V as the nominal transmission pressure. The trend is toward 4,160. And reflecting increased concentration, loads and transmission distances, particularly for cables, 7,200 V is gaining in

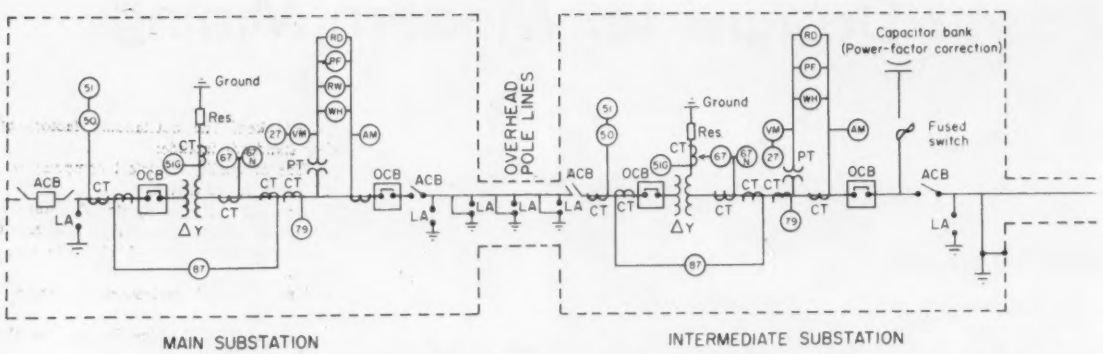
Where to Find It . . .

AC Power Systems ..... p 257

Design procedure . . . Surface distribution . . . Overhead pole lines . . . Portal control stations . . . Underground distribution . . . Distribution control stations . . . Mine power centers . . . Utilization distribution

DC Power Systems ..... p 265

Conversion capacity . . . Transmission limits . . . Sectionalization . . . Ground protection



THE AC SYSTEM includes main and intermediate substations, over head pole lines, portal control station, section control station, load center and utilization distribution. AC-system components are shown in the above diagram. Standard symbols and numbers are listed below.

ACB—Air circuit breaker
LA—Lightning arrester
CT—Current transformer
PT—Potential transformer
OCB—Oil circuit breaker
Res—Resistance
51G—Time-delay overcurrent ground relay in neutral circuit
87—Differential relay
67—Directional overcurrent relay (phase)
67N—Directional overcurrent relay (ground)
50—Instantaneous overcurrent relay (phase)
51—Time-delay overcurrent relay (phase)
79—AC reclosing relay
27—Undervoltage relay
VM—Voltmeter
AM—Ammeter
WH—Watthour meter
RW—Recording wattmeter
PF—Power-factor meter
RD—Recording demand meter
85—Pilot wire receiving relay
74—Alarm relay
64—Ground relay

Field Reports

Designs for Distributing AC Power—How better power for modern mining results from good design. *Coal Age,* August, 1958, p 78.

AC Continuous Mining—AC power distribution for an all-AC continuous mining setup. *Coal Age,* November, 1958, p 78.

AC Operating Regulations—How 23 states regulate the use of AC in coal mining. *Coal Age,* November, 1958, p 92.

Overcurrent Settings for DC Circuit Breakers—Guide to DC breaker settings based on feeder and trolley capacities and rail weights. *Coal Age,* December, 1958, p 96.

Wireless Control of 33,000-V Power—How two-way radios are used to monitor and control circuit breakers at main substations. *Coal Age,* March, 1959, p 82.

Cables for AC Underground—Choice and installation of cables for underground use. *Coal Age,* May, 1959, p 90.

Designs for Safe, Efficient AC Power Systems—Ground-continuity monitoring and effective voltage regulators for power-system improvements. *Coal Age,* June, 1959, p 98.

Central Circuit-Scanning System Monitors and Controls Outlying Units—Positive, automatic and continuous monitoring and control of outlying substations and fans. *Coal Age,* October, 1959, p 102.

AC Cables for Coal (Pt. I)—Selection, manufacture and testing of AC cables. *Coal Age,* November, 1959, p 104; corrections, January, 1960, p 81.

AC Cables for Coal (Pt. II)—Installation, use and maintenance of AC cables. *Coal Age,* December, 1959, p 128; corrections, January, 1960, p 81.

New Mining-Machine Protection—Device for protecting both men and equipment without the need of a separate frame-ground wire. *Coal Age,* January, 1960, p 88.

AC for Underground—Evaluation and selection of power systems. *Coal Age,* April, 1960, p 92.

popularity, with possibly 13,000 at some future date.

Two-step systems are relatively few in coal mining; where they have been adopted the primary voltage usually is 13,000.

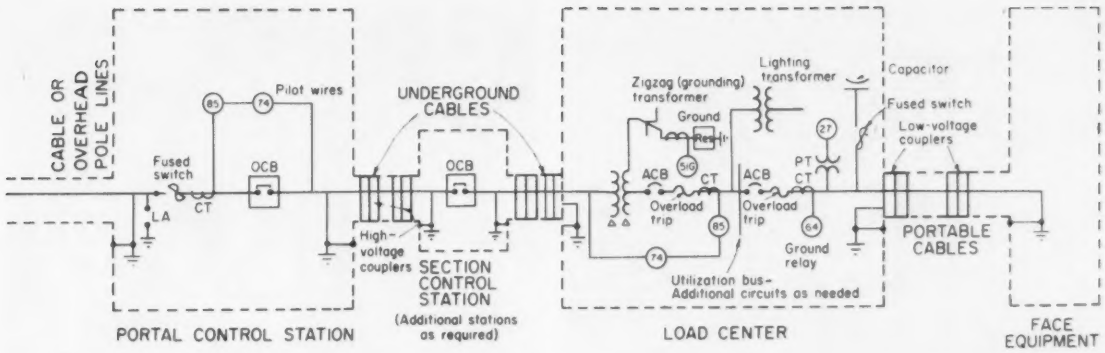
Stability of voltage is a measure of the quality of power. Voltage quality is becoming an increasingly important factor. AC equipment at the face is more sensitive to voltage fluctuations. Consequently, voltage quality must be given full consideration.

MAINTENANCE—Proper maintenance is essential to safety and reliability. The power system should and can be designed to make maintenance easier and safer.

3.5 ELECTRIC EQUIPMENT AND WIRING, INSPECTION AND MAINTENANCE—Electric equipment and wiring at every mine shall be inspected systematically as often as necessary to insure safe operating conditions and at least once a month. A report of each inspection shall be made by an authorized person, and a copy shall be furnished to a responsible official and kept on file at the mine. The report shall state definitely the condition of the equipment in each station and substation, of the conductors for each power and lighting circuit, and of the motors and controlling appliances for all electric equipment, particularly with reference to the necessary safeguards and protective features. Equipment and circuits found to be defective shall be taken out of service immediately and repaired before they are used again. A check inspection form is recommended to facilitate making the inspection and report.

At least every 6 mo all grounding conductors shall be inspected for broken connections and each grounding conductor and its connection with the ground shall be tested for abnormal increase in resistance.

All stationary machines and equipment shall be tested every 6 mo, or more fre-



quently if found necessary, for open grounding connections or increase in grounding resistance or to detect the presence of grounds.

All mobile and portable equipment shall be tested every 3 mo, or more frequently if found necessary, for open grounding connections or increase in grounding resistance or to detect the presence of grounds.

FLEXIBILITY — The selection of adequately rated system components and proper circuit arrangement is essential to obtain flexibility. Flexibility, however, is not necessarily measured by extra capacity alone. It is provided by the system that is expandable in economical kilovolt-ampere blocks. Provisions for load growth and change, without undue costs, are the criterions for a flexible power system.

Design Procedure

Exercise good judgment in planning the power system. Proceed only after all data have been collected and all facts known.

Plan to distribute power in one or two steps, whichever proves more economical.

IN DESIGNING A POWER SYSTEM, considerable judgment must be exercised, even after all the facts are determined. It is not always possible to express in numbers or determine by formulas all the components of a distribution system.

Design procedure includes, among other things, the following:

1. Make a plan of the area, indicating location of buildings, structures, mine entrances and boreholes and points where power will be required for various operations.
2. Determine the amount and nature of the loads.
3. Select the primary and secondary voltages.
4. Locate the main transformer station, switchgear house and distribution lines.
5. Arrange circuit layout.
6. Provide circuit protection for the primary and secondary distribution systems.
7. Make provisions for power-factor correction.
8. Select lighting facilities for the preparation plant, offices, shops, change-house and the outside working area.

To get an overall picture of what is required in designing the power system it is essential to make a plan of the proposed system or the system to be revised. A one-line diagram will serve this purpose. This diagram should show the amount and nature of each load with respect to locations and load sites. It will help to develop the initial plan and give an idea of how the various electrical components will unite to meet system needs.

3.4 ELECTRIC-SYSTEM MAP—A map of the mine showing the location of all circuits and stationary electric equipment comprising the electric system shall be kept. It shall show by suitable designation (1) size of conductors, (2) location of circuits and equipment and (3) capacity in horsepower, kilovolt-amperes and voltage appropriate for each motor, generator, rectifier, and transformer. The nature of the duty of each piece of electric equipment shall be indicated.

From the basic diagram, the power company's substation and the coal company's switchgear house can be located. Normally, the power company owns the substation that reduces the incoming voltage to a level selected by the coal company. From this point the coal company takes over. And it is at this point where the coal company must begin designing its distribution system.

Voltage Selection

A coal company's distribution system starts with a main substation or switchgear house where power is purchased. The main substation may reduce the voltage to the final levels of 220 or 440, or it may drop it only to 7,200 to 4,160 or 2,400 for transmission to load centers for final reduction. The number of voltage steps and the choice of voltages depends upon system load, transmission distance, safety and limitations imposed by mine laws.

The selection of voltage levels is probably the most important single factor in the design of a power system. Closely associated to voltage level are the limits on the amount of power that can be economically distributed from one point. Once these two decisions have been made they are difficult and costly to change.

2.1.20 HIGH VOLTAGE (HIGH POTENTIAL)—High voltage is voltage above 650.

PRIMARY VOLTAGE—Utilization voltage distribution—in the 440-V level—is limited to approximately 1,500 ft. Consequently, high-voltage distribution must be simple and flexible to accommodate frequent moving of underground load centers. Most new mines are selecting 7,200 V as the primary distribution voltage. Only recently has a 7,500-V cable connector been developed for use with the 7,200-V system.

The cost of equipment rated at 7,200 V is only slightly more than for 4,160 or 2,400 V, and the cable cost is considerably cheaper. The lower price for cable results from the fact that the higher voltage permits the use of smaller conductors to supply the same load at the same distance. A 7,200-V system can supply the same load at three times the distance of a 4,160-V system using the same-size cable. A 2400-V system is capable of supplying only one-third that of a 4,160-V system. The cost of equipment for a 13,000-V system is three times that for a 7,200-V system. This will probably limit the use of 13,000 V.

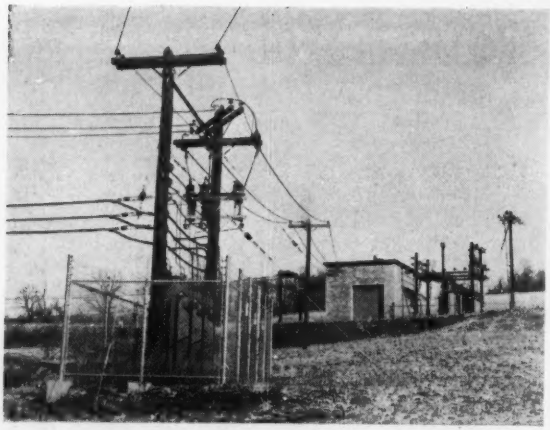
Higher primary voltage, in most cases, means lower cost, greater flexibility and greater margin for expansion. More advantages can be gained with the 7,200-V system.

A 4,160-system costs less than 2,400. This is explained by the fact that switchgear for a given interrupting capacity costs less than 2,400-V equipment. Also, with a 4,160-V system a 1,200-amp circuit breaker, for example, will often carry full load current, whereas in a 2,400-V system the more expensive 2,000-amp breaker would be required. More kva can be carried in 4,160-V lines, resulting in fewer lines for a given power load. Cable costs are less for 4,160 because less copper is required.

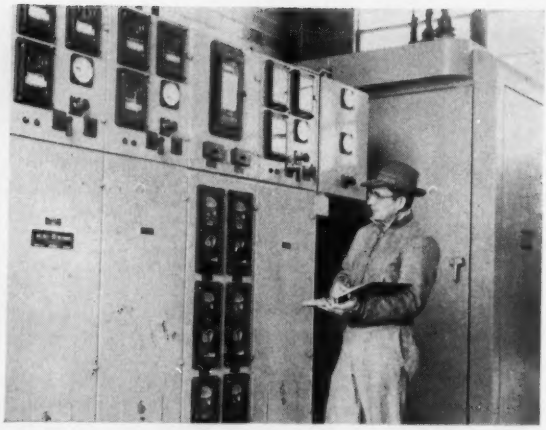
The largest metal-enclosed circuit breakers made for 2,400 V are 150 mva maximum interrupting rating. For 4,160 the maximum is 250 mva. This allows for a much larger system to be built using 4,160 V without resorting to current limiting reactors or other expensive means of reducing fault currents.

UTILIZATION VOLTAGE—The advantages of higher voltages for secondary distribution are even more apparent. Theory indicates that the utilization voltage should be as high as possible, up to 650 V—voltages above 650 are classified as high voltage. In practice, however, 440 and 480 V are almost universally chosen because of the availability of standard 440- and 480-V utilization equipment.

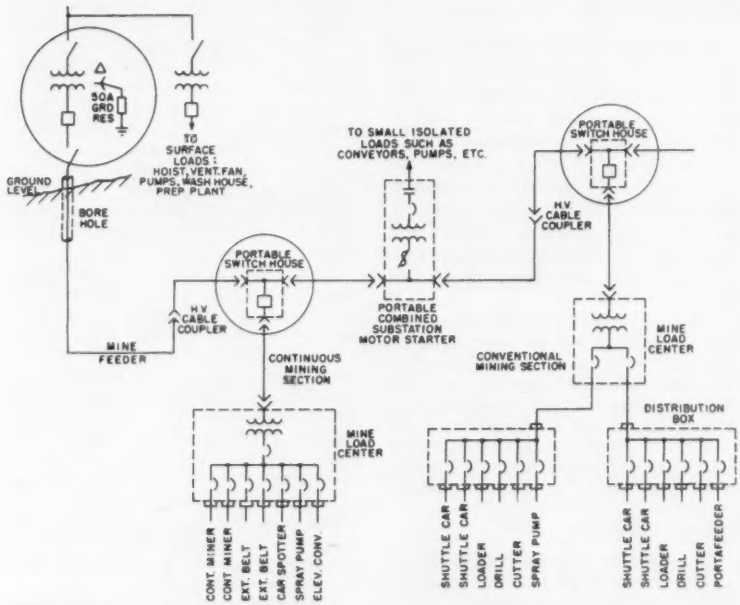
Economically speaking, there is seldom any reason for selecting 220 V instead of 440 or 480, except where mine laws prohibit higher voltages. A 220-V system costs approximately 35% more than 440-V system because there is more current per kva to be



AC POWER DISTRIBUTION SYSTEM should be designed for future load growth and safety. Reliability also is important.



SEVEN-FRAME SWITCHGEAR ASSEMBLY consists of an incoming power panel, metering panel and five distribution panels.



TYPICAL POWER SYSTEM for an AC mining operation. Equipment in circles are the surface substation, where voltage is reduced to distribution level, and underground switchhouses.

carried; thus, larger circuit breakers and feeder conductors are required.

Surface Distribution

Make sure that the surface distribution system contains sufficient capacity for future load growth.

Have all incoming power metered at one point.

Provide necessary safety features for the protection of personnel and equipment.

Improve system power factor by proper motor sizing, and use of synchronous motors and capacitors.

ALTHOUGH MAIN SUBSTATIONS usually are owned by the power company, various switching and protective devices normally are coal-company property. The point of purchased power may involve only switching and protective devices or it may include transformers and associated equipment.

The selection and arrangement of this equipment determines how well the complete system performs under normal and abnormal conditions.

6.1 BUILDINGS, TYPE—Substation buildings shall be of fireproof construction, well ventilated and equipped with a door or a gate that will permit the building to be locked to prevent unauthorized entrance.

Transformers

The primary function of a transformer is to change electrical power from one voltage level to another. This makes it possible to transmit, distribute and utilize AC power at the most economical and effective voltages.

Transformers are the very heart of the surface substation. Associated equipment serves to protect, control and monitor the overall power system. Transformers contain primary and secondary windings. The primary receives current at the input voltage and the secondary sends it out at the output voltage. The ratio of primary to secondary voltage is the same as the ratio of turns in the primary and secondary windings.

Practically all transformers are single-phase or combined three-phase units, the latter combining all phases in a single case or tank. The selection is usually a matter of preference but the three-phase units are gaining in popularity.

6.2.1 TRANSFORMERS FILLED WITH FLAMMABLE OIL—If the substation building contains transformers filled with flammable oil, the floor and floor drains shall be so arranged that oil will quickly collect in a suitable drainage or storage system provided for the purpose either inside or outside the building as may be advisable.

6.2.2 TRANSFORMERS RATED ABOVE 25 KVA—If the transformers within the building are rated above 25 kva and are filled with nonflammable liquid, the transformer cases shall be equipped with pressure-relief vents connected to a chimney or flue that will carry gases generated by arcing within the cases to the outside of the building.

6.2.3 DRY-TYPE TRANSFORMERS—For new installations indoors, transformers rated above 25 kva shall be dry-type or nonflammable liquid-filled.

The extent of transformation depends on the size of the system (load demand), distance voltage is to be transmitted and voltage limits imposed upon the system by mine laws. Since the voltages of transformers are fixed, the rating of an individual unit is

determined by the amount of current flowing through it. Care must be exercised in selecting the correct rating to insure efficiency and adequate power for the system.

The voltage, winding connections, impedance and capacity are the main factors to be considered in selecting transformers.

The secondary voltage of transformers usually is determined by state mine laws. If the maximum voltage for distribution underground is limited, for example, to 4,160 V the transformer secondary voltage will be just that. However, there are a few exceptions where surface transmission distance is extremely long. In special cases it is desirable to go to higher voltage for surface distribution and reduce it to the permissible underground-distribution level at the mine entrance.

Voltage regulation is another factor which must be considered. Voltage drops in some cases can be as much as 5% to the underground power center. Correction for this drop can be made at the load-center transformer.

Cost of cable and equipment at different voltage levels varies considerably. From an economic standpoint, and since cable costs represent, in some cases, as much as 60% of the initial costs, comparisons must be made to justify the selection of certain voltages. Costs per kilovolt-ampere per 1,000 ft at different voltage levels are as follows:

Voltage	Costs per kva per 1,000 ft (Dollars)
2,400	5.25
4,160	3.00
7,200	2.00
13,000	1.20

Transformer capacity should be such that additional loads can be added to the system without increasing transformer capacity. Kva loads carried by surface transformers often reach 75% to 85% of the connected horsepower.

System Grounding

The most used and best way of grounding distribution systems is the neutral ground method. It provides better protection and is simpler.

2.1.10 EFFECTIVE GROUNDING—Effective grounding means that the path to ground from circuits, equipment or conductor enclosures shall be permanent and continuous and shall have carrying capacity ample to conduct safely any currents liable to be imposed on it. The path shall have impedance low enough to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit. Where bonded or mechanically connected track is available, such track shall be considered the grounding medium.

Neutral grounding connections can be obtained in two ways:

1. Connect transformers delta-Y.
2. Use zigzag grounding transformers when delta-delta connections are used.

The chief advantages of the delta-Y connection are that it provides a neutral connecting point for grounding purposes, and is the simplest and best way of stabilizing the Y secondary neutral. This method does not require extra equipment to establish a neutral.

If the system is connected delta-delta there is no neutral connection point available. However, a neutral can be established by installing an external grounding transformer. It consists of a three-phase winding with no secondary. Each phase of this transformer is connected to a different line of the system. The grounding transformer neutral is then the same as the Y-connected system.

When a neutral has been established for the system, there also must be a method of grounding the neutral. The most desirable practices in mining are: (1) resistance grounding and (2) solid grounding. Resistance grounding is more widely used.

In resistance grounding the neutral is connected to ground through one or more resistances regardless of whether the secondary is connected delta-Y or delta-delta with a grounding transformer. The main reason for using resistors in the grounded-neutral system is to limit the amount of current during faults. The advantages are:

1. Minimizing electric shock hazards to personnel.
2. Reducing burning effects in faulted electric equipment.
3. Reducing mechanical stresses in circuits and equipment.

Solidly grounded neutrals are connected directly to ground without any provisions for limiting current. The disadvantage of this method is that personnel are exposed to large ground currents when faults occur.

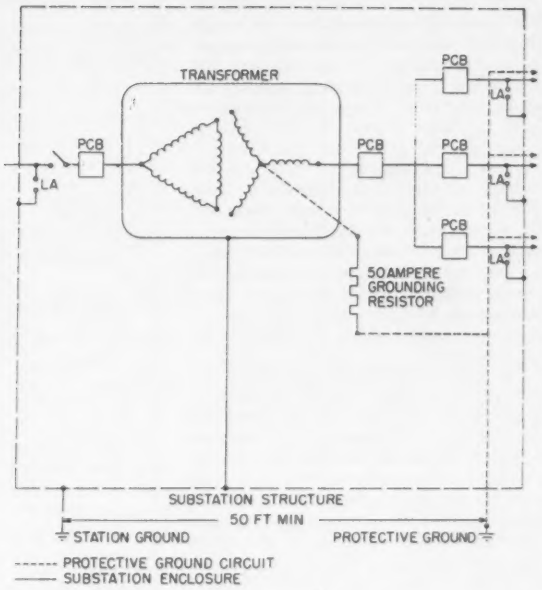
The ohmic value of the resistor should be high enough to limit ground-fault current to a low value, yet small enough to permit sufficient ground-fault current to be selectively relayed by the circuit breaker relay. A 25-amp resistor will meet these requirements.

14.10 FAULT DETECTORS FOR HIGH-VOLTAGE CIRCUITS UNDERGROUND—High-voltage circuits shall be provided with devices for detecting faults to ground. Preferably, such devices should be capable of removing power from the circuits instantly in the event of a ground fault.

Main Circuit Breaker

Factors to consider in selecting circuit breakers are voltage rating, continuous current-carrying capacity, interrupting capacity and momentary-current capacity. Oil or air circuit breakers can be used.

Disconnect switches are one of the protective devices used in electrical circuits. They are knifeblade-type switches which



NEUTRAL GROUNDING SYSTEM for surface substation.

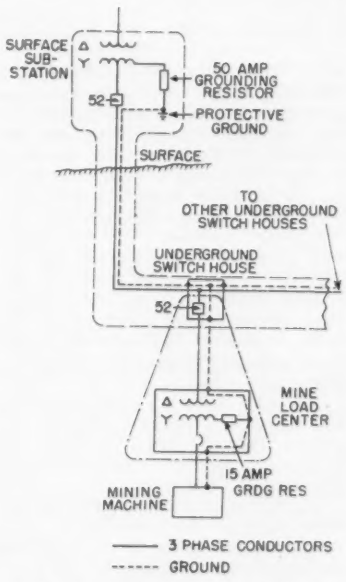


DIAGRAM shows protection provided by primary switching devices.

provide a means of isolating transformers and associated equipment from the source of power. These switches, normally, are not installed in the line to interrupt load but are used as a visible means of isolating the equipment when repairs or construction work are being carried on. This type of switch provides a large air space between live wires and equipment, which prevents leakage of power to the equipment. They also permit workmen to visually check that the system is disconnected from the power source. These switches are usually mounted on overhead pole lines and are opened and closed manually by insulated pole hooks that engage holes in each blade. They are normally mounted ahead of the oil or air circuit breaker.

On high-voltage systems the oil-type circuit breaker is used to guard against overloads or short circuits, and also to permit sectionalizing the system to isolate trouble. It should be noted, however, that air circuit breakers are being used more and more on high-voltage systems. The amount of protection that an oil or air circuit breaker provides depends primarily on the relays associated with it.

Circuit breakers are designed for momentary and interrupting ratings, and with automatic interrupting features. Momentary rating is the amount of current that a breaker will withstand, including short circuits from all sources. The breaker should safely open on any current within its rating.

The interrupting rating is the ability of a breaker to interrupt a fault current between the maximum and minimum designed voltage rating of the breaker. The rating is measured in megavolt-amperes.

Interrupting fault currents automatically is achieved by built-in tripping devices or by relays connected to the breaker. There is a wide variety of relays to choose from and the selection depends on the amount of protection required.

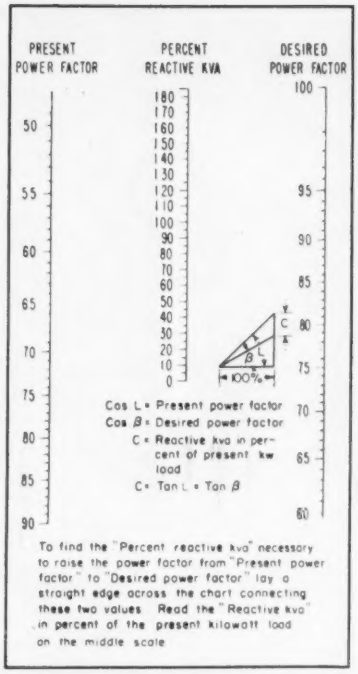
Facilities at the main substation normally consist of a master oil circuit breaker (one that provides protection for the overall system) and several branch circuit breakers that feed various loads. The master breaker provides additional back-up protection in case a branch circuit breaker fails to operate when a fault occurs in any one branch. The purpose of branch circuit breakers is to isolate trouble in a particular branch without interrupting service to the other branches.

Relays

Relays detect trouble in a distribution system. They are used in conjunction with circuit breakers to control the operation of breakers when faults occur.

Relays are connected into the system through current or potential transformers, often called instrument transformers. Their purpose is to insulate the relays from line voltage and to reduce line current and voltage to values that can be applied to the sensitive mechanisms that are common in relay design.

These devices are classified with respect to the rate of speed at which they operate. Basically, these classifications are: (1) instantaneous, (2) high-speed, (3) time delay and (4) combinations of the three.



BEST METHOD OF CORRECTING POWER FACTOR in a given case can be determined by a careful study of surrounding conditions. Without taking into consideration special features, the amount of corrective KVA may be determined by the use of the above nomograph copyrighted by Westinghouse Electric Corp.

Instantaneous relays, as their name implies, operate within a few cycles after faults are detected. High-speed relays differ from instantaneous in that they operate within three cycles or less.

Time-delay relays are those that do not operate until a predetermined time has elapsed. The time ratings are usually adjustable but there are a few that have the time rating built into them.

Distribution systems can be protected from almost any fault condition that might develop within a system by proper selection and coordination of relays. The various relays are named with reference to the protection they provide. Those most often used are: (1) differential, (2) overcurrent or undercurrent and over-current directional, (3) overvoltage or undervoltage, (4) phase balance and (5) reclosure. All are available in various time ratings. For a more detailed discussion of the various types of relays most commonly used, see *Coal Age*, May, 1958, p 78.

Lightning Arresters

Protection against overvoltage caused by lightning is accomplished by installing lightning arresters in the system. How much protection against lightning a system should have depends on the location of the system and whether or not the location is subject to frequent lightning strokes. Installation costs vs equipment value and lost time due to interruptions must also be considered.

4.5 LIGHTNING PROTECTION—High-potential power lines and the equipment fed by them shall be protected against lightning and voltage surges.

Lightning strokes result in an overvoltage in the conductors. Arresters limit the accompanying surge by providing a path for it to travel between line and ground without permitting normal current flow. After a surge of lightning has been directed to ground, the arrester must prevent normal current in the system from also flowing to ground. Summing up, arresters perform two operations: (1) direct the surge to ground and (2) stop the current in the system from also flowing to ground after the surge has passed.

Several types of arresters are available for various applications:

1. Distribution-type.
2. Line-type.
3. Station-type.

Distribution-type arresters are used to protect transformers, cables, capacitors, meters and circuit breakers. They are designed to permit mounting on poles and crossarms. They are relatively inexpensive and are easy to install.

Line-type arresters are similar to the distribution type but are more suited for protecting small equipment.

Station-type arresters provide better protection than the other two. They are used, as the name implies, to protect stations and other equipment of extreme importance.

Lightning arresters, as well as all substation equipment frames, should be connected to the main substation ground grid.

Power-Factor Correction

There are few AC systems that do not require power-factor correction. Correction can be made either at the substation for system correction, at the load for individual correction, or both. This latter is not an uncommon practice. As a matter of fact power-factor correction is being treated with as much importance today as any other phase of the power system. Once the money-saving potentials of power-factor correction are recognized, it will be applied to more systems. The saving is not in power bills alone but also in the reduction of load on the system which permits equipment to operate on a more normal power supply, thus reducing repair bills on the equipment.

The device most often used in mining systems to correct power factor is the capacitor. This, however, is not the only means. Other correction includes the use of synchronous motors, and the proper application of induction motors.

Capacitors can correct and bring power factor up to 90 to 95%, which normally takes the mine out of the penalty area and reduces the reactive power in the system. Some systems may require overall correction and also correction at the centers of groups of induction motors. Still other systems would require correction at only one of the two locations.

Correction at the main substation consists of installing a capacitor bank with

sufficient ckvar (capacitor kilovolt-amperes-reactive) to bring the power factor to the desired rating. The ckvar value is determined by the amount of kw and kvar of the system. From these values the kva and power factor can be calculated.

Overhead Pole Lines

Install transmission lines to reduce line reactance. Spacing, size and type of conductors are factors affecting line losses.

Install overhead pole lines to meet code requirements.

MOST DISTRIBUTION SYSTEMS include overhead pole lines even though, in some instances, they are short. The two-step voltage arrangement normally requires more overhead construction than the one-step system. Transmission of high voltage from main substation to intermediate substations often involve several miles of overhead power lines.

The spacing of conductors determines, in part, the amount of reactance in transmission lines which, in effect, causes voltage drop and poor power factor. Lines spaced far apart produce more adverse effects on each other than lines spaced closer together but this has its limits in overhead-pole-line construction.

The size and type of conductors with respect to radius and surface conditions help reduce line reactance. For the average mine setup, these two factors have very little effect on the amount of reactance in the system. Conductors are usually selected in accordance with the transmission distance and voltage level.

A ground wire normally accompanies the power conductors. Lightning arresters should be installed at intervals of approximately 1,500 to 2,000 ft. The ground wire is connected to the ground side of the arresters. This method has proved most satisfactory and is widely used in surface distribution systems. Code provisions for surface power lines are as follows:

4.1.1 CIRCUITS CARRYING 15,000 V OR LESS—Overhead high-potential power lines of 15,000 V or less on mine property shall be at least 20 ft above roads and driveways and at least 15 ft above the ground at points accessible to pedestrians. They shall be supported and guarded adequately to prevent contact with surface structures as well as with other circuits. The height of such power lines shall be not less than 28 ft above railroad tracks. When heavy equipment or loads on equipment must pass under power lines where clearance is questionable the power shall be removed from these circuits until the equipment has passed safely under them.

4.3 GROUNDING WIRES, PROTECTION—Grounding wires attached to the surface of a wooden pole shall be protected by a wooden casing and shall not make contact with cross-arm braces or other exposed metal parts.

4.4 GUY INSULATOR—An insulator shall be located in each guy attached to a pole or structure that carries supply conductors of more than 300 V to ground or in any guy exposed to such voltages. This guy insulator shall be at least 8 ft above the ground. However, a guy insulator is not required where the guy is effectively grounded such as by an electrical connection to grounded steel structures or to a ground connection on wooden poles.

4.6 OVERCURRENT PROTECTION—High-potential power lines shall be protected against excessive overcurrent.

Portal Control Station

Plan to transmit power into the mine as near to the load center as possible.

Provide protective devices required by the code.

AT THIS POINT of the installation there are several standards for distributing AC power underground. These standards provide safety for men and equipment and contribute to an efficient underground distribution system.

The power should enter the mine as near the load center as possible for two reasons:

1. To reduce the amount of high-voltage cable underground.
2. To minimize voltage drop between the substation and load center.

In most cases the substation will be located near the place where power is taken underground. Consequently, it is not necessary to provide an extra switching station equipped with circuit breakers and necessary protective relays, such as, overcurrent and phase balance, as well as ground-fault detectors and lightning arresters. On the other hand, if the entrance is located some distance from the substation it would be necessary to provide a separate installation, including all the protective devices listed.

Ground Protection

Protection of underground high-voltage systems can be achieved in several ways but probably the best method is the pilot-wire system employing differential-type relays. A small amount of line current is permitted to flow in the pilot wires through the secondary of current transformers. These pilot wires are carried with the power conductors.

The amount of current at one end of the line is the same as at the other end. When the current in the pilot wire becomes unbalanced, due to faults in the line, the relay operates and opens a circuit breaker. This method provides phase-to-phase as well as ground-fault protection.

An additional feature of this protective system is a relay for continuously checking the condition of the pilot wires. If the wires become short- or open-circuited, the relay will operate, indicating that the system is no longer protected against faults. The lines can then be inspected and repaired.

4.7.1 LIGHTNING PROTECTION—Each exposed power circuit that leads underground shall be equipped with lightning arresters of approved type at the point where the circuit enters the mine. If the power circuits leading underground are 100 ft or more long on the surface, suitable lightning protection shall be provided at the generating station or substation and at the point where the circuit enters the mine.

4.7.2 SURFACE DISCONNECTING SWITCH—Each power circuit leading underground shall be provided with a switch in each conductor of the circuit for visibly disconnecting the circuit from the source. This switch shall be placed on the surface not more than 500 ft from the point of entrance to the mine.

4.7.3 OVERLOAD PROTECTION—All circuits leading underground from substations and transformer stations shall be provided at their source with current-interrupting devices of such capacities and so installed and adjusted that the circuit will be opened if the current in the circuit exceeds the safe carrying capacity of the conductors leaving the stations. Three-phase delta or Y-connected AC circuits shall be protected by a fuse or a circuit breaker in each ungrounded wire.

4.7.4 CABLES, TYPE—Cables in shafts, boreholes and underground passageways leading from the surface shall be of a type approved for the service intended, installed in an approved manner and guarded against damage from external sources.

4.7.5 CABLE INSULATION AND SUPPORT IN SHAFTS—All power conductors in shafts shall be covered with approved insulating materials throughout or guarded in an approved manner. However, grounded conductors of grounded DC systems shall be supported on insulators but need not be covered with insulation. Conductors shall be securely fastened in such a way as to support them properly. They shall be supported out of contact with combustible materials. When the length, weight and construction of a shaft cable are such that suspension from its upper end only would subject the cable to possible damage, it shall be supported in an approved manner at such intervals as may be necessary to prevent undue strains in the sheath, insulation and conductors.

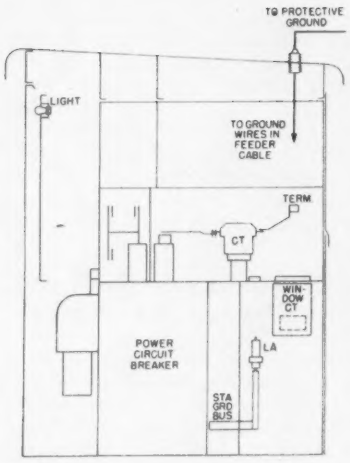
4.7.6 SHAFT CABLES, MECHANICAL PROTECTION—Shaft cables shall be so placed or protected that they will not be subject to damage from moving cages and skips, ice, coal or other falling materials or to damage from mine water and electrolysis.

4.7.7 BOREHOLE CABLE INSTALLATION—All conductors passing underground through boreholes shall be installed in an approved manner to prevent undue strains in sheath, insulation or conductors, and damage by chafing of cables against each other or against the borehole casing.

Underground Distribution

Provide switching facilities at the bottom of boreholes or shafts.

Use cables and cable couplers having



SWITCHGEAR arrangement for typical underground circuit.

sufficient capacity with built-in safety features.

IN CONJUNCTION WITH THE SURFACE SWITCHING ARRANGEMENT, high-voltage cables entering the mine through boreholes or shafts are equipped with circuit breakers at the bottoms of these openings to interrupt power feeding into the mine in case of emergency and also for repairs.

5.5 DISCONNECTING SWITCHES—Disconnecting switches shall be installed in all main power circuits near the bottom of shafts, boreholes and other places where these power circuits enter the mine. High-voltage disconnecting switches shall be accessible only to properly qualified persons and shall be arranged so they can be locked in the open position, or a danger sign must be placed on the switch by the person who opens it. Disconnecting switches also shall be provided near the beginning of all high-voltage branch circuits. They shall be located preferably in well-ventilated fireproof rooms.

Cables

Insulated multiple-conductor cables equipped with ground wires and a conducting shield over both ground and power conductor are used to transmit high voltage underground. Type SH-D cables with adequate kilovolt rating are used in most installations. The length of these cables normally is kept to a maximum of 1,000 ft. They are connected by high-voltage couplers or potheads.

5.1 LOCATION—All underground power circuits other than portable cables shall be installed in a permanent manner and so located as to minimize possibility of damage by (a) mine water, (b) falls of rock and coal or (c) movement of strata. Protection from damage by wrecked trips and blasts should also be considered.

It is recommended that power circuits shall be installed only in regularly inspected intake airways. AC power circuits installed in the vicinity of trolley wires shall be covered or placed so as to minimize the possibility of being struck by current collectors, such as trolley shoes or wheels, or by other haulage equipment.

5.2 CABLES, HIGH-VOLTAGE—In selecting the type of cable, including the mechanical and electrical characteristics of the insulation and outer covering, such factors as electric shock and fire hazards, deterioration from mine water and electrolysis and means of suspending or otherwise supporting the cable must be considered.

Cables for high-voltage circuits underground shall be either the metallic armored or nonmetallic sheathed type. Metallic armored cables may be supported (1) on messenger wires or (2) directly on hangers, both of which shall be suspended by means of insulators if supported in coal or other combustible materials, or (3) they may be buried in accordance with Sec. 5.4 which follows.

Unshielded nonmetallic sheathed cables shall be installed in metallic conduit.

When conductors or cables are enclosed in metallic armor, conduit or shields the armor, conduit or shields shall be electrically continuous throughout and effectively and permanently grounded.

5.4 BURIED CABLES IN ENTRIES AND SLOPES—Power cables buried in the mine floor shall be not less than 12 in below combustible material. Where such cables pass under mine tracks they shall be not less than 36 in below the tracks, unless adequately protected against crushing from the weight of passing trips or heavy equipment.

Couplers

From a safety viewpoint it is better to use couplers equipped with padlocks, key interlocks, or fitted with pilot-wire connectors. Any one of these safety devices will permit only authorized personnel to disconnect the couplers and also eliminate the possibility of persons connecting them while repairs are being made.

Distribution Control Stations

Provide distribution control stations equipped with circuit breaker and protective relays at intervals of 2,000 ft, and at branch circuits.

AS TRANSMISSION DISTANCES INCREASE it is necessary to sectionalize the cables at intervals of approximately 2,000 ft. This means that a circuit breaker or other disconnecting device is installed in the line at these intervals. This also applies to branch circuits that feed other sections of the mine. In addition to the circuit breaker these branch circuits should include necessary protective equipment.

2.1.35 SECTIONALIZING SWITCH—A sectionalizing switch is a switch used for connecting or disconnecting (or both) adjacent electric circuits.

As in the surface substation, phase and ground overcurrent protection should be provided. These relays should be chosen to coordinate with backup relays. The ground relay should be selected to operate from a balanced-flux current transformer and to pick up ground-fault currents in the neighborhood of 5 amp. The ground-fault relay in the control station nearest the load should be an instantaneous relay.

Cable monitoring equipment is often used in the control station to monitor ground wire continuity from the control station to the mine power center.

Mine Power Center

Install transformer with sufficient kva capacity to handle connected horsepower load.

See to it that mine power centers incorporate all the required safety features.

THE HIGH-VOLTAGE CABLE from the control station is terminated at the load-center with the same type of coupler used in the intermediate sections, with one-half of the coupler permanently mounted on the load-center frame. The power conductors are connected to the transformer and the ground wires are grounded to the frame.

The purpose of the load center is to reduce the high voltage to actual utilization voltage and to provide switching and fault protection for branch circuits. It is a combination power and distribution center. However, individual units may be installed for the same purpose, although the combined unit seems to be preferred.

Transformers

Dry air-cooled or inert gas-filled transformers can be used underground. The former are more widely used because, among other things, the liquid-filled units must have a separate split of air.

The dry-type transformer should have a 5% low tap to compensate for a 5% system voltage drop. The secondary (utilization) voltage usually is 480 V when permitted by state laws. Where state laws limit utilization voltage to 220, voltage regulation and cable size become such difficult problems that the use of AC is discouraged. The 480-V three-phase system with neutral resistor ground provides a phase-to-ground voltage of 277 V.

The load-center transformer winding must contain a delta winding. If only a single-voltage primary is required, the primary winding should be delta to permit a secondary neutral connection. If a delta-wye dual-voltage primary winding is necessary the secondary winding must be delta-connected. In this case a zig-zag grounding transformer must be used to establish a secondary neutral point.

The capacity of mine-power centers usually is based on approximately 1 kva per connected horsepower. Standard capacity of power centers for conventional-mining equipment is 225 kva, and for continuous-mining equipment, 300 kva. Units as high as 600 kva are being used to provide power

for as many as three sections. However, this setup produces serious voltage-regulation problems because portable cables are too long.

Circuit Breakers

Back-up protection is provided for each branch or bus circuit by installing a breaker between the transformer and bus. This gives added protection when relays are properly coordinated. It is, however, possible for both breakers to trip at the same time, which would cause a delay in the other branch circuits. But, in most instances, when a fault occurs in any one branch it will trip only the branch circuit breaker and not disturb the others.

Air circuit breakers are mounted on the low-voltage panelboard to protect the low voltage cables. Each breaker feeds to a low-voltage receptacle, which supplies power to individual face equipment.

Circuit breakers are of the molded-case type which have integral, thermal and magnetic trips for phase protection. An undervoltage trip coil is included in each breaker to provide a positive method of tripping the breaker under no-voltage or undervoltage values. Ground faults are detected by the balanced-flux current-transformer method. Sensitive relays open the undervoltage trip circuit on ground faults of 3 to 7½ amp.

Utilization Distribution

Provide equipment with portable cables and cable couplers of sufficient size to carry connected load.

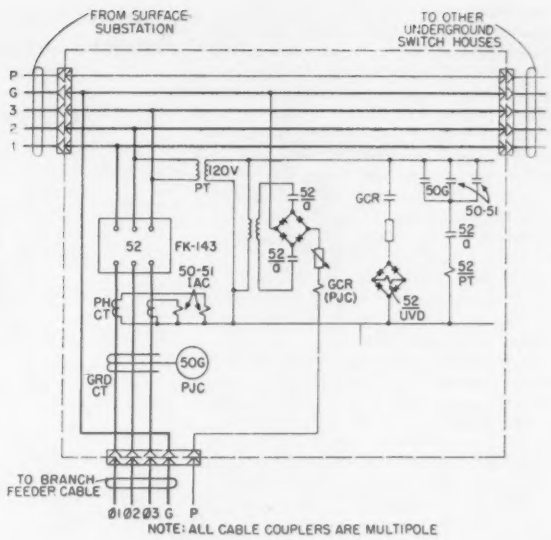
Keep cable lengths as short as possible to limit voltage drop.

THE ELEMENTS OF CONCERN at this point in the distribution system are cables, couplers and ground continuity. Once cables and couplers are selected and installed, the only everyday task remaining is checking ground continuity. This is vital if safety for men and equipment is to be maintained.

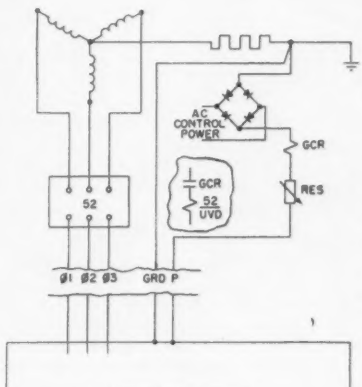
13.3 CABLES FOR PORTABLE AND MOBILE EQUIPMENT—Cables used for connecting portable and mobile equipment to a source of energy shall be flexible, adequately insulated and of approved flame-resistant type. Such cables shall have ample current-carrying capacity to prevent damage by overheating and shall have short-circuit protection at the point of connection to the power circuit.

Cables shall have an approved trolley tap with insulating handle or an equivalent device for making connections safely to the power circuit.

13.4 PORTABLE CABLES, INSPECTION AND MAINTENANCE—The operators of portable equipment shall examine cables daily for abrasion and other defects. If a cable breaks down in service or causes a person to receive a shock, it shall be put out of service at once and shall not be used until it has been repaired. Permanent splices in portable cables shall be electrically and mechanically efficient and shall be waterproof. Portable cables having five temporary splices shall be replaced by new cables or by cables in which permanent splices have been made before the next shift begins.



ELEMENTARY diagram for underground switchhouse.



GROUND CONTINUITY check relay scheme for mine power center.

Cables usually are sectionalized in 50- and 100-ft lengths so that their bulk will not be excessive. Keeping cables short helps reduce voltage drop.

Couplers attached to the ends of the cable sections should be designed to prevent injury to persons connecting and disconnecting them.

Ground-continuity checking devices are difficult to maintain in portable cables, especially those that are spooled on reels. Special efforts should be made to maintain continuity.

DC Power Systems

Plan conversion-equipment installation to meet the increasing power demands.

Weigh the possibilities of converting manual substations to automatic controls.

PROVIDE sufficient feeder capacity and stay within maximum transmission limits. Have DC system sectionalized.

CONVERSION EQUIPMENT INCLUDES the old-reliable converters and m-g sets, but the standard unit today is the mercury-arc rectifier, including the glass-bulb type. A few metallic rectifiers of the selenium type are in service and units based on germanium, silicon and other metals are now available.

Conversion Capacity

Higher horsepower per machine and per section is requiring an increase in the capacity of rectifiers and other conversion equipment. A recent series of tests on power required by continuous miners indicates that the capacity for a single section (miner and shuttle cars, roof drill, etc.) should be at least 200 kw.

Dull bits on miners and other equipment have a major effect on power demand and consumption. It one test with dull bits, miner advance was 20 ft, demand was 82.4 kw and consumption was 32.47 kwhr. Time was 50 min. With sharp bits, advance in 54 min was 30 ft. Demand was 69 kw and consumption was 31:33 kwhr (J. O. Cree, 1956 Coal Convention, American Mining Congress).

AUTOMATIC OPERATION—The high cost of labor naturally dictates making substations automatic. Equipment now is available for positive, automatic and continuous monitoring and control of outlying substations and fans by a central circuit-scanning system *(Coal Age,* October, 1959, p 102). Basically the system is an electrical one, using plug-in relays which are easy to install. The scanning system requires two wires which contact every station to be controlled.

PORTABILITY—For the maximum in

convenience and efficiency, the trend is toward portable conversion units. Such units also may be placed in permanent locations —to serve main-line haulage, for example. Or stationary types may be employed at some saving in cost.

Portability facilitates keeping transmission distances short. However, if the cover is shallow, some mines have felt that the lower cost of pole lines and surface facilities, even when offset by the cost of boreholes, warranted keeping conversion equipment on the surface, even with 275 V as the nominal voltage. With 550 V, the reduction in number of moves otherwise necessary is an added reason for considering keeping conversion equipment outside.

Heavy locomotives bring up the problem not only of placement and capacity of substations but also the effect on the remainder of the system as the locomotive passes a given point. To reduce disturbance in face operation as a result of locomotive operation, substations may be equipped with automatic load distributors.

Transmission Limits

The maximum distance DC can be transmitted from the substation depends on a number of factors, and must be calculated for each individual operation. Balancing everything, the distance should not exceed 3,000 to 3,250 ft for an 800-amp average transmission, 300 V at the nips and 250 V at the machine.

Even with the maximum in feeder capacity it is difficult to maintain adequate voltage, let alone rated, for 250-V motors at distances much over 4,000 ft. Incidentally in increasing feeder capacity, it is better to use a number of smaller cables than one large one because the current-carrying capacity is greater. At 30C ambient temperature, 45-deg rise, for example, approximate ratings are: 500,000 cir mils, 800 amp; 1,000,000 cir mils, 1,230 amp; 1,500,000, cir mils, 1,550 amp.

ALUMINUM FEEDER — A decidedly lower relative cost makes aluminum very advantageous for bare feeders alongside trolley wires or elsewhere. It has greater bulk, however, and consequently the advantages are largely offset by the increased insulation and jacket when used for high-voltage power cables or low-voltage trailing cables. But with bare feeder, aluminum has about 70% the current-carrying capacity of copper, and 3 ft of aluminum feeder can be bought for the price of 1 ft of copper.

Sectionalization

Safety, quick isolation of fault areas, and quick replacement of damaged facilities are among the benefits of sectionalization. The latter applies particularly to the growing custom of using short lengths of cable with push-pull connectors in distribution of power at the face. Connector design is such that power is removed before the circuit is opened.

Recommended sectionalizing practice may be summarized as follows:

1. Provide in every instance sufficient capacity in the feeder and return so that the most remote dead short will open the overcurrent protective device, usually an automatic reclosing circuit breaker.

2. Install an overcurrent protective device in the circuit between each two substations at a point where resistance both ways is equal. If enough copper is used so that a ground at any point will open the protective devices at both substations, no intermediate protection is necessary. A section insulator, or "dead block," may be used between substations if they need not be paralleled.

3. Insert a disconnecting switch or protective device at intervals of not over 1,500 ft in all power lines.

4. Install an overcurrent-protective device in each circuit leaving a substation—fuses, or manual or automatic-reclosing circuit breakers. Circuit breakers should have trip-free operating mechanisms. The exception is where a substation feeds only one haulage unit, in which case only one station breaker is required.

5. Place an overcurrent protective device at each branch circuit.

6. Protect each circuit feeding a local section or territory with an overcurrent device.

7. Install overcurrent protection at the supply end of each circuit to pumps or other fixed loads.

8. Install switches to cut power off unimportant and infrequently used branch or stub circuits.

9. Protect each mining setup with an overcurrent device.

10. Keep overcurrent circuit-breaker settings or fuse ratings as low as practical for good operation. Specific settings are listed in a discussion of the subject in *Coal Age*, December, 1958, p 96.

11. Cut power off all idle territories during non-operating times. If it is necessary to run a pump or some other one unit, special overload protection no greater than needed should be provided.

Unit Resistance of Common Sizes of Copper Wire and Steel Rail

COPPER WIRE

Size, CM	Resistance, Ohms per 1,000 Ft
1,500,000	0.00719
1,200,000	0.00899
1,000,000	0.0108
750,000	0.0144
500,000	0.0216
300,000	0.0360
211,000	0.0509

STEEL RAIL

Weight	Equivalent Each Rail, CM of Copper	Resistance, Ohms per 1,000 Ft (both rails bonded and cross-bonded)
30	300,000	0.0180
40	400,000	0.0135
50	500,000	0.0108
60	600,000	0.0090
70	700,000	0.0077
80	800,000	0.0067
90	900,000	0.0060
100	1,000,000	0.0054

Ground Protection

The solid wire from machine frame to ground provides protection to men from short circuits—under most conditions—but no protection to the machine. Thus, some other provision is necessary. The original unit, still widely used, was the fuse, either in the junction or distribution box or in the trailing-cable nip. A major disadvantage is that a ground fault of low intensity, say 100 amp, is not sufficient to blow a fuse—or operate a circuit breaker—rated or set at 200 amp.

The best answer to this latter condition is a three-pole circuit breaker, with one pole in the grounding circuit equipped with a 5- or 10-amp current-limiting relay. A low-intensity fault will trip the breaker as a signal for corrective measures, while a high intensity fault will be cut off before severe equipment damage occurs.

A new protective device for personnel and machines without the use of a frame-ground wire has been developed. The device

1. Permits the use of two-conductor cable in a completely safe and approved manner.

2. Provides positive protection for ground faults occurring anywhere on the machine.

3. Provides positive protection for short circuits occurring anywhere on the machine or its trailing cable.

4. Acts to remove power in the event of a broken or open cable conductor.

5. Distinguishes between short circuits and normal operating overloads.

6. Prevents energizing equipment when a dangerous condition exists.

7. Eliminates possible severe arcing that can occur with a ground fault when a grounding conductor is employed.

8. Is essentially "fail-safe."

The device always removes power from the machine *and* its trailing cable. It is designed for use on mobile mining machines to provide complete protection against the electrical faults expected in operation of the machine and cable. This is accomplished without a grounding conductor in the trailing cable. At present, only 250- and 500-V DC models are available.

The complete unit includes a small electronic oscillator unit mounted on the machine, a pushbutton station, also on the machine, and a receiver unit in a safety circuit center at the outby end of the trailing cable. The safety circuit center also includes the customary circuit breaker of adequate capacity for the machine and is equipped with plugs and receptacles for easy cable attachment.

Stripping For Profit

Where to Find It . . .

Preparing for Operation . . p 268
Getting coal reserves . . . Mapping the land . . . Studying the coal . . . Using the data . . . Planning reclamation . . . Studying markets . . . Locating the plant . . . Planning mine layout . . . Selecting equipment . . . Studying equipment ranges . . . Estimating mining cost . . . Moving cost . . . Balancing units . . . Radio communication

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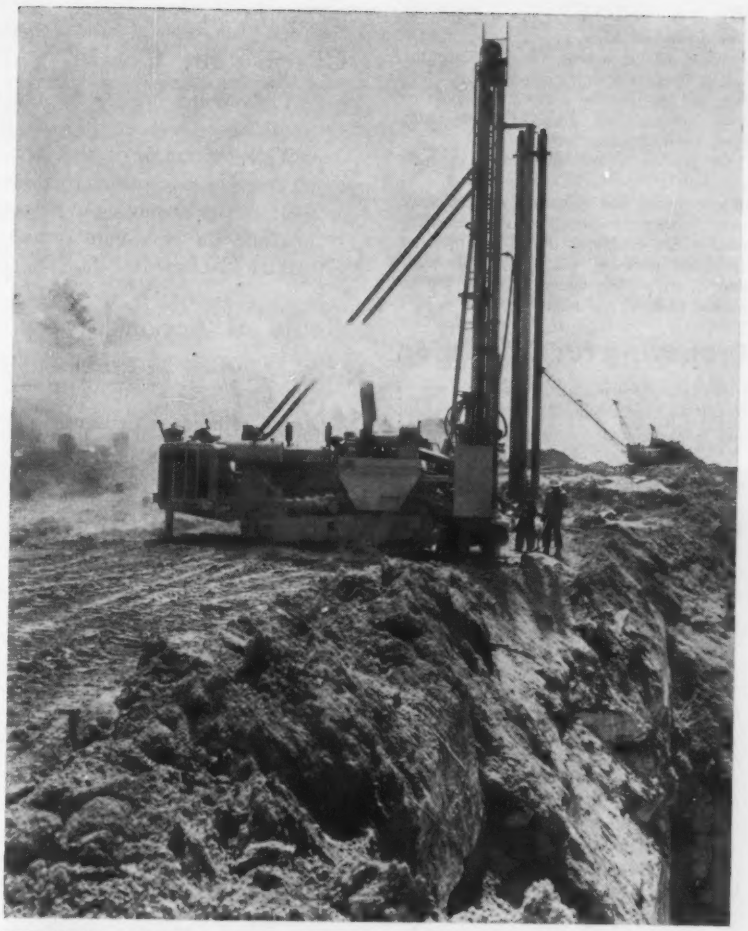
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THE GOAL in overburden preparation is to get maximum fragmentation at the lowest possible drilling and blasting cost.



PIT CLEANUP should be left for auxiliary machines so that stripping units can concentrate on moving a maximum of material

SKILLFUL PLANNING well ahead of the time operations begin provides the foundation for profitable strip mining. Since the cost of opening a strip mine increases every year and the pressure grows to maintain or lower mining costs, planning is becoming more important than ever.

To provide a smoothly running profitable operation requires the combined skills of engineering and operating officials. Since most of the preliminary work demands technical skills, engineers should do most of the basic planning. Once the basic planning is completed, operating skills will be needed to make the plans work.

Preparing for Operation

Consolidate enough coal-bearing land to justify the capital expenditure for equipment and to provide continuity of operation.

Check property lines and mining rights of all tracts.

Prepare work maps showing property lines, coal thickness, borehole locations, overburden thickness and coal outcrop.

Accumulate information about the coal seam by core drilling and making outcrop openings if possible. Plot this information on the work maps.

Select a centrally located plant site, if possible, so that haulage distances will be as short as possible.

Construct a permanent haul road between plant and pit with good alignment and grade for fast haulage with minimum wear and tear on trucks.

Choose equipment suited to the natural conditions and for a balanced mining cycle.

Design preparation facilities to meet market needs.

GETTING COAL RESERVES—Before a new strip mine goes into operation, two fundamental problems should be solved. These problems are: (1) acquiring and consolidating sufficient coal reserves to justify the capital expenditure for mining and preparation equipment, and (2) gathering reliable information about the coal bed and stripping conditions.

Investigating coal properties and evaluating information about the coal seam demands the application of engineering skills. The scope of the engineering study will vary from property to property, depending on the information already available, the topography and the nature of the coal seam. For instance, a company operating deep mines and owning strip reserves in the same seam will not have to make as intense a study as another company considering opening a new mine in a new area.

The size of the property and the topography influence to a great extent the size and type of stripping operation that can be planned. For instance, equipment that works well in flat areas will not necessarily perform equally well in mountainous regions. Furthermore, equipment capacity should be matched to the reserves of coal available. It would not be wise to choose high capacity machines for a mine with limited reserves. And small equipment may not be an economical investment at a property with large reserves.

Charting the Course

1. Combine engineering and operating skills to analyze mining conditions.
2. Select machines that not only will perform effectively in the pit but also are justified by the reserves of the mine.
3. Design a mining cycle that fully utilizes the potential of each machine for maximum output at lowest cost and with minimum capital investment.

Route of Action

1. Prepare the foundation by prospecting thoroughly, mapping in detail, selecting equipment for the conditions and planning long-range mining procedures.
2. Choose the most effective technique for breaking overburden.
3. Analyze stripping methods, including various possible combinations of machines and how to use each most effectively.
4. Balance loading-shovel capacity to stripping capacity.
5. Select haulage equipment that matches the capacity of loading units and meets the demands of the terrain.
6. Plan the power-distribution system not only to supply adequate power but also to provide positive protection of personnel and equipment. Incorporate flexibility in equipment to meet changing pit conditions.
7. Devise drainage schemes as part of the basic stripping plan. Prevent water inflow to the pit where feasible.

Today's Practice Trends

Stripping shovel size reaches new high as construction of 115-yd unit begins. Giant stripper will uncover 14,000 tpd and handle 36 million yards of overburden per year.

Wheel excavator capacity reaches 3,500 cu yd per hour, a fivefold increase over the original machine.

Better controls for smaller stripping machines up to 10 cu yd capacity for faster operating cycles, greater flexibility and ease of operation and decreased maintenance.

Regardless of the topography of the land and its area, it is extremely important to assemble as much information as possible about ownership, mining rights and price per acre.

Information about the coal and the material covering it should be accumulated as quickly as possible as property is purchased or leased. Getting this information is an engineering job that includes topographic surveying, mapping and prospecting.

As rapidly as information is accumulated it should be recorded and analyzed. The numerous questions about mining rights, land ownership, coal thickness and quality, and thickness and type of overburden can be readily answered if all information is funneled to a central office and organized for ready reference.

MAPPING THE LAND — Informative maps in the hands of competent engineers and operating supervisors are important tools in planning development, day to day operation and equipment moves. Modern methods make it possible to produce accurate maps in less than half the time required for ground surveys. And there is no sacrifice in accuracy.

With the aid of low-cost aerial maps, engineers can estimate coal reserves, plot property lines and coal outcrops, locate boreholes, lay out roads, locate spoil areas and calculate overburden ratios. The speed with which these maps can be made also makes it possible to use a monthly progress map to make an accurate, fast calculation of the number of cubic yards of overburden and tons of coal removed, and to direct stripping operation for the next month.

Some field survey control is necessary in aerial mapping. In rough, mountainous terrain, the tellurometer, a new electronic instrument, can cut the time and cost in making field surveys. The device, which applies the radar principal to distance meas-

Big bulldozers continue as overburden movers in thinner and soft cover, usually operating in teams.

Hydraulically controlled rippers, mounted on the rear of more powerful tractors, gain in breaking coal and overburden.

Seismic analysis of overburden enables operators to determine quickly, easily and inexpensively the best way to break and handle overburden.

Capacity and flexibility of horizontal and vertical rotary dry-type overburden drills increases as new models undergo field tests.

Ammonium nitrate-oil mixtures continue to lead in breaking rock, but operators are stressing better mixing and packaging as well as better handling in the pit.

Mechanical charging devices make possible greater loading density and a significant saving in time and effort.

Moving overburden by explosives alone enables some operators to reduce backfilling costs, handle overburden more effectively on inside curves and reduce hoisting distance.

Modern electronic devices increase the efficiency and usefulness of aerial mapping.

The three-axle semitrailer bottomdump truck remains the favorite for coal hauling. Use of alloy steel and aluminum gains in trailer construction to reduce weight and increase payload.

Tomorrow's Possibilities

Introduction of 13,800-V pit equipment which will require design and development of portable cable, field switches and methods of connecting cable sections for this higher voltage.

New tire designs for big coal haulers that will combine good flotation, better load-carrying ability and shock-absorbing qualities with low maintenance.

Development of the 100-ton coal hauler, either a double-tractor shuttle unit or some other completely new design. More powerful engines, stronger transmissions, better cab design, easier steering and improved brakes should result from advances in truck capacity.

Improvement in both vertical and horizontal drilling machines, including revolving frames and two masts for vertical work and twin heads for horizontal units.

Introduction of the 125-yd shovel and 40-yd dragline.

Contract engineered drilling and shooting service, including analysis of overburden, planning drilling and charging, and loading and shooting.

ment, consists of a monitor and a slave station. Both are completely mobile and can be carried by one man.

Line of sight is required between points on the line to be measured. Adverse weather, including rain or fog, do not decrease the accuracy of the tellurometer and distances up to 20 mi can be measured.

By limiting distances to not less than 2,500 ft, closures of better than 1:12,000 are possible. Adjusted surveys made by this method in West Virginia, Pennsylvania and California have been in the order of 1:25,000.

When it is not practicable to have an aerial survey made, a ground survey may be needed. The extent of this survey will depend on the topography and whether information is available in the form of government maps and geological bulletins.

If deep mining was done in the area, mine maps on file with the State department of mines will provide a valuable source of information. They will show how close the old workings came to the outcrop and frequently show dip and thickness of the coal, and unusual geological conditions such as faults.

STUDYING THE COAL—As soon as basic maps are available, information about the coal seam and any conditions which might influence mine planning should be gathered. This information should be plotted on maps as it is accumulated.

Drilling is the most satisfactory method of prospecting coal for full and accurate information. This work can be done either by churn- or diamond-drilling equipment. Diamond drilling provides a core section of the overlying rocks and the coal, and therefore yields very valuable information. A churn drill in the hands of a skillful operator also can provide accurate data but results depend on the skill of the drill operator. A coal core, on the other hand, can be examined visually and half of it sent to the laboratory for complete analysis. The other half can be kept for reference.

Several companies have found it helpful to photograph coal cores to provide a permanent graphic record of the core as well as to conserve storage space. The physical characteristics of the coal are frequently destroyed when a core is split and prepared for analysis. A photograph provides a permanent record of the appearance of the core.

Development of a bottom-discharge bit that prevents air circulation around the core has made possible the successful application of air core drills. Air coring is said to make possible 100% core recovery nearly every time, even when it is necessary to stop half way through a seam. A very important advantage of air coring is that thin, soft partings of clay or other material are not washed out as they would be when using water. Another advantage is that water lines and pumps are eliminated.

A new lightweight handheld diamond coring drill weighing only 45 lb is available for prospecting under as much as 200 ft of cover. In shallow drilling the unit recovers up to an 8-in core and in deeper drilling it recovers a $5\frac{1}{16}$-in core. One man can operate it on 2 to $2\frac{1}{2}$ gal of fuel per day.

Diamond drilling results have been improved by perfection of the wire-line coring technique for coal prospecting. The wire-line coring method differs from the conventional method in that a retractable inner tube is used. At the end of each run, the core-laden inner-tube assembly is hoisted to the surface through the drill string, as opposed to the conventional method wherein it is necessary to pull the entire string and core barrel to recover the core. Increased coal recovery, lower diamond cost and saving in drilling time are advantages of the method.

A quick, easy and inexpensive method of determining the consolidation of overburden in strip operations has been developed. The new process, called seismic analysis is based on the principle that sound or shock waves travel through different subsurface materials at varying speeds and along different paths. By this method the operator can determine whether overburden can be ripped or whether it will need to be drilled and blasted. Two men, after a minimum of training, can perform a seismic study in a matter of hours.

If the coal bed outcrops, prospecting should be done at regular intervals along the outcrop. The modern tool for this job is the bulldozer. Once the bulldozer is on the outcrop, it can make an opening faster and more economically than by hand methods. Outcrop openings and trenches extending above the coal bed, can yield other useful information on the type and nature of the rock covering the coal and how much outcrop coal must be removed before merchantable coal is reached.

USING THE DATA—In any prospecting program, sufficient holes should be drilled or outcrop openings made to get an accurate picture of the coal and overburden. Prospecting results, including seam thickness and elevation, should be plotted on special maps as quickly as possible. This

information then should be used to construct coal-thickness contours as well as contours of the top of the coal. These two sets of contours along with surface-contour maps are useful in computing overburden ratios and planning stripping methods. Coal-thickness contours are especially helpful in planing operations when the coal bed is not uniform in thickness.

PLANNING RECLAMATION — Two problems demanding more and more attention are: (1) restoring spoil areas to usefulness after mining is completed and (2) preventing stream pollution. The type of restoration work depends on such factors as contour of the land, type of overburden as well as State regulations. Sometimes the only immediate steps that can be taken after completing stripping are backfilling and leveling because the spoil will not support plant life until it has decomposed by weathering for several years. In any event the material in the spoil bank should be analyzed to see if it will support plant life before planting is begun.

STUDYING MARKETS—A study of today's market as well as tomorrow's possibilities will serve as a guide in planning mining methods as well as selecting and designing preparation facilities. For example, the type of preparation facilities demanded for preparing a steam coal would probably not be the same as those required in processing metallurgical coal. Furthermore, overburden preparation methods and coal loading procedures could be influenced by market requirements.

LOCATING THE PLANT—A number of factors govern the choice of a plant site. Among these are topography, access to rail or water transportation, sufficient building area and distance to the coal to be mined. If wet-washing facilities are to be included in the plant, a reliable water supply will be important, along with room for thickeners or sludge ponds. Refuse-disposal area also must be considered in choosing a plant site.

PLANNING MINE LAYOUT—As soon as the preparation plant site is chosen the most advantageous point to open the strip pit should be selected. Then a permanent haulage road connecting the pit with the preparation plant should be laid out. Time and money can be saved by laying out a preliminary road on a topographic map and then making estimates of the earthwork required to make the road. By making this preliminary layout field work will be reduced to such items as marking road alignment, setting grade stakes and making minor adjustments.

Good road alignment and good grades pay off in faster haulage and lower truck maintenance. A solid, well drained roadbed enables trucks to travel at the top recommended speed and keeps wear and tear to a minimum.

The method of attacking the coal is governed by a combination of the following factors: type, thickness and contour of the overburden; thickness, quality and area of coal available. If the coal bed does not outcrop, a box cut will be needed to open the pit. If the coal outcrops a considerable distance above drainage and contour mining is planned, it may be necessary to spend a great deal of money to provide a solid, all-weather road to the coal level.

Sometimes it may prove more economical to build a bin, feeder and conveyor to haul coal downhill to the preparation plant and restrict truck haulage to nearly level roads along the outcrop. Whatever the choice of transportation system, the goal is the most economical method possible.

SELECTING EQUIPMENT — Topography, coal reserves, expected selling price of the coal, type of overburden, spoil area and tonnage of coal desired per shift are some of the major factors influencing the selection of equipment. Since other machines should be matched to stripping capacity, the selection of the stripping unit will influence the choice of the other machines.

The capacity of a stripping unit will be influenced considerably by the estimated number of cubic yards of overburden that can be removed to recover a ton of coal at a profit. Once the economic limit is established the stripping unit can be selected.

STUDYING EQUIPMENT RANGES—Profiles or cross sections of the proposed stripping area along with key equipment dimensions and ranges are valuable in selecting the machine or combination of machines best suited to the conditions. This type of diagram will show how wide the pit can be made, what the spoil area will look like and how each machine can be used most effectively.

Consider the needs of a specific mine in

Field Reports

Big Shovel Stripping—A 70-yd shovel removes 1,800,000 cu yd of overburden per month to expose 80,000 tons of coal at an Ohio mine. Overburden, drilled with a rotary dry-type vertical unit, is broken with nitrate-oil blasting agent. To simplify cold-weather starting of 335-hp engines on 51-ton coalhaulers, individual electric engine heaters are employed on nonloading shifts. *Coal Age,* July, 1959, p 108.

Selecting Diesel Fuels—Less possibility of harmful deposits and corrosion in the engine can be expected from choosing the proper diesel fuel. *Coal Age,* July, 1959, p 132.

Rippers Reduce Rock-Breaking Cost—Substantial savings can be realized by operators who replace drilling and blasting with ripping. Under typical conditions, a 320-hp tractor with ripper and dozer blade can move 300 to 600 cu yd per hour. *Coal Age,* August, 1959, p 124.

Wheel Excavator—Latest wheel has a rated capacity of 3,500 cu yd per hour; can dig at 9 to 100 ft above the coal; can move dirt 450 ft; and can spoil up to 119¼ ft above the coal. *Coal Age,* August 1959, p 82.

Bulldozer and Dragline Strip Thin Seam—A bulldozer cuts down loose material to within a few feet of the solid rock, which is broken with nitrate-oil mixture for removal by a 6-yd dragline. Close supervision of blasting practices minimizes rock-breaking cost. *Coal Age,* September, 1959, p 106.

Choosing the Right Tractor Shoe—How matching the right size and type of track shoe to the job pays off in increased production and longer service life. *Coal Age,* September, 1959, p 120.

Redesigned Shovel for Two-Seam Loading—A longer boom and dipper stick and a "conning tower" for the operator enables shovel to load lower seam in trucks traveling on upper seam 8 ft above. *Coal Age,* September, 1959, p 122.

Thick-Seam Stripping—Scrapers, push loaded by big bulldozers, remove overburden on 30 to 35-ft seam at Wyoming mine serving new power plant. Stripping ratio now is about 1:1, maximum will be 2:1. *Coal Age,* October 1959, p 74.

Helicopter Transports Executives—A three-passenger helicopter, first in the coal industry, makes it possible for executives to visit 14 different centers of activity in 2 hr 45 min. It took 14 hr to cover the same territory by car. *Coal Age,* October, 1959, p 74.

Bulldozer Spearheads Low-Cost Stripping—Cutting down 70% of the overburden and leveling shovel spoil, a twin-engine bulldozer provides

maximum flexibility of operations. A diesel-powered shovel removes lower portion of cover at Pennsylvania operation recovering 40-in coal. *Coal Age,* November, 1959, p 98.

Special Shovel Solves Tough Loading Problem—A horizontal-thrust loader skims off the top layer of coal without disturbing a fireclay parting. It then casts clay aside before loading lower bench of coal. In addition to simplifying coal loading, the new shovel makes possible a 2% reduction in ash content. *Coal Age,* November, 1959, p 141.

Old Bus is Portable Shop—An old school bus serves as a supply center and portable shop. *Coal Age,* November, 1959, p 144.

Seismic Technique Simplifies Overburden Analysis—A quick, easy and inexpensive method of analyzing overburden employs a refraction seismograph. By this method the operator can determine the most economical method of breaking and removing overburden. Two men, after a minimum of training, can perform seismic study in a few hours. *Coal Age,* December, 1959, p 102.

Stripping 36-in Coal—Modern equipment and well-planned methods lead to higher efficiency at an Ohio mine recovering 36-in coal under 50 ft of cover. Blasting chart eliminates guesswork in charging holes with blasting agent. *Coal Age,* January, 1960, p 83.

Starting Diesels in Cold Weather—How understanding of cold-weather diesel facts will enable the owner of diesel-powered equipment to start engines quickly and also eliminate possible engine damage through incorrect starting procedures. *Coal Age,* January, 1960, p 132.

Stripping in Waterlogged Overburden—Long-range planning of pit operations plus close attention to day-to-day problems provide the basis for successful stripping in water-soaked flat areas near stream level at a Kentucky operation. *Coal Age,* February, 1960, p 128.

Thin-Seam Stripping and Augering—Big bulldozers are major stripping units in Alabama operations recovering 28- to 36-in coal. Nitrate-oil blasting agent is primed with 150-grain detonating fuse which is connected to 50-grain fuse linking holes. Four-man crews produce up to 200 tpd with self-moving augers. *Coal Age,* March, 1960, p 74.

Dump Truck Becomes Tractor—A remodeled truck formerly on a dump-bed frame now is pulling 62-ton coal trailers at an Ohio mine. *Coal Age,* April, 1960, p 154.

Overburden Preparation—While taking a close look at today's methods operators are trying or studying completely new drill designs and refined make-your-own blasting agents which could mean revolutionary changes in the future. *Coal Age,* May, 1960, p 94.

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relation to overall efficiency and cost rather than in terms of dirt-moving capacity only.

ESTIMATING MINING COST—An estimated mining cost based on engineering studies is the best guide in determining the economic stripping limit. The estimated figure should include a complete breakdown similar to the accounting method that will be followed when the mine is in operation. For example, labor and material costs should be estimated for such items as drilling, shooting, stripping, explosives, pit cleaning, coal loading, haulage, road building, fuel, oil, grease, maintenance, supervision, depreciation and any other items needed to build up the estimated cost as accurately as possible.

MOVING COST—First cost is not the only expense involved with a stripping machine. It must be erected on the job and perhaps torn down and moved to a new site. Mounting labor costs must be given careful thought in the moving and erection costs of equipment. These two indirect costs alone may set an economic limit to the size of the unit because it is not always possible to amortize equipment during the life of an operation. Where it is not feasible to do this, medium and smaller size machines have the added advantage of low-cost moving to another location.

If the acreage or reserves of mineable coal is not large enough to justify the purchase of a large dragline or shovel, the ability to move a unit to a new site becomes an important factor in equipment selection. Mobility of equipment is particularly desirable for small or medium size companies in acquiring new coal reserves, especially in areas where large strip reserves no longer are available.

BALANCING UNITS—Once the capacity of a mine has been decided and the major stripping machine chosen, other units, such as drills, coal shovels and trucks should be selected to build a balanced production cycle. After the production cycle is established, any change in one of the cycle components will upset the balance. Unless other changes are made, inefficiency will result.

It is sometimes practicable as well as economical to add flexibility to the operation by adding a small or medium size shovel or dragline. For example, a small machine sometimes can be used profitably to remove cover in a tandem operation where a large shovel or dragline takes the major portion of the overburden.

RADIO COMMUNICATION — Where mining plans call for the various machines to be working far apart or in more than one pit a radio communication system is valuable. Money spent on the radio setup frequently can be repaid in better supervision and less equipment downtime. For example, equipment downtime can be substantially reduced because stripping units can report trouble immediately. Thus repair crews and facilities can be called to the scene promptly. If the job requires parts or materials not on hand, they can be ordered from the warehouse in a matter of seconds merely by picking up the microphone and calling.

Another important benefit of radio communication is that supervisory efficiency can be improved considerably by reducing the time needed to cover the ground to check operations. With radio, much of the routine of checking on the progress of stripping and pit conditions can be done by calling the pit, thus reducing supervisory driving to a minimum and leaving more time for planning.

Preparing the Overburden

Select blasthole diameter that will make possible the desired distribution of explosives in the strata.

Choose a drilling pattern that will enable explosives to be used most effectively.

Log drillholes to provide shooters with a guide to charging holes.

Provide blasting charts to eliminate guesswork in charging holes.

Consider mixing your own blasting agent to reduce the cost of breaking rock.

Employ delay shooting where vibration is a problem.

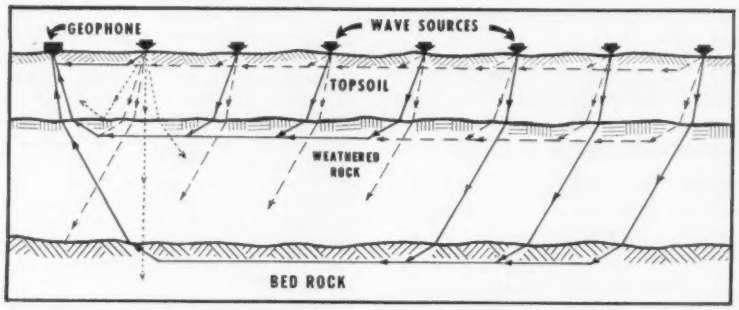
Study the possibility of using explosives alone to move a major portion of the overburden into the pit.

Consider the advantages of shooting against a buffer where conditions are favorable.

THE SUCCESS of a stripping operation depends to a considerable degree not only



HELICOPTER enables mining executives to save valuable time in visiting scattered centers of activity in mountainous terrain.



SEISMIC ANALYSIS of overburden makes it possible to determine quickly, easily and economically the best method of removing overburden.

on how well overburden is broken but also on how much it costs to break the material. The objective in overburden preparation therefore is to achieve the best fragmentation possible while keeping drilling and blasting costs within economic limits. In establishing drilling and shooting practices mine management must weigh the benefits of maximum fragmentation against the higher cost of breaking the rock finer. To meet the desire for lower cost overburden preparation, mine operators are now exploring new possibilities in drilling and blasting techniques.

By employing the seismic method of overburden analysis, strip operators can measure the overall consolidation of subsurface materials, including rock hardness, stratification, fracturing and the degree of weathering. The seismic method also makes it possible to determine rippability quickly. In some instances where material can be ripped, savings of 12 to 60% have been reported.

VERTICAL DRILLING — Rotary dry-type units lead in drilling vertical holes although improved vertical augers are still proving themselves valuable. A wide assortment of rotary dry-type machines is available to meet the needs of both large and small mines. Some of these machines are mounted on crawlers, others are carried on truck frames. Hole diameter varies from 5½ to 12 in.

Most operators in thick cover and producing large tonnages favor the big crawler-mounted rotary machines capable of drilling up to 12-in holes. These large-diameter holes make it possible to concentrate explosives in the hard layers and to use less-dense low-grade explosives, such as, the make-your-own mixes. They also make it possible to break a larger volume of the overburden with fewer blastholes.

Some typical results with big vertical rotary dry-type machines are as follows:

1. An average of 1,100 ft of 9-in hole in 8 hr while drilling in 50 ft of medium-hard shale covered by 12 to 40 ft of sandstone. Bit life averages 21,000 ft of hole (*Coal Age*, January, 1959, p 59).

2. An average of 625 ft of 10⅝-in hole per shift in hard, sandy shale that ranges from 45 to 70 ft thick. Bit life is 13,704 ft (*Coal Age*, July, 1959, p 108).

3. Up to 700 ft of 9-in hole per shift in shale or shale mixed with sandstone in 40 to 50 ft of cover (*Coal Age*, March, 1960, p 70).

4. An average of 1,200 ft of 6¼-in hole in one shift, using a machine with a 55-ft mast in overburden that includes 30 to 40 ft of sandstone. Bit life is 4,000 to 6,000 ft (*Coal Age*, February, 1957, p 98).

5. In 75 to 100 ft of overburden made up of hard shales and sandstone, an improved-design crawler-mounted unit operated by a two-man crew, drills 400 to 900 ft of 9-in hole in 8 hr. It is able to do in 16 hr a day and one day less per week the work formerly requiring round-the-clock operation 7 days a week (*Coal Age*, July, 1958, p 92).

When drilling through clay or soil with a rotary machine, some companies have experienced difficulty with the hole squeezing together. They have solved this problem by augering through the soft material and then changing to the regular oilwell-type bit. Although this method requires two extra tool changes, the faster penetration of the soft material and elimination of squeezing more than offsets the disadvantages. One Illinois operator saved $8,000 per year in bit cost with this method.

At some mines auger stems are being used successfully with rotary dry-type machines to help bring the cuttings to the surface.

MOBILE DRILLS—Where flexibility is extremely important and operations are in the medium or small-size range, there are many smaller, lighter and less expensive vertical rotary machines available. Today's designs include both truck and crawler-mounted units, usually equipped to drill 4⅝- to 6¼-in holes.

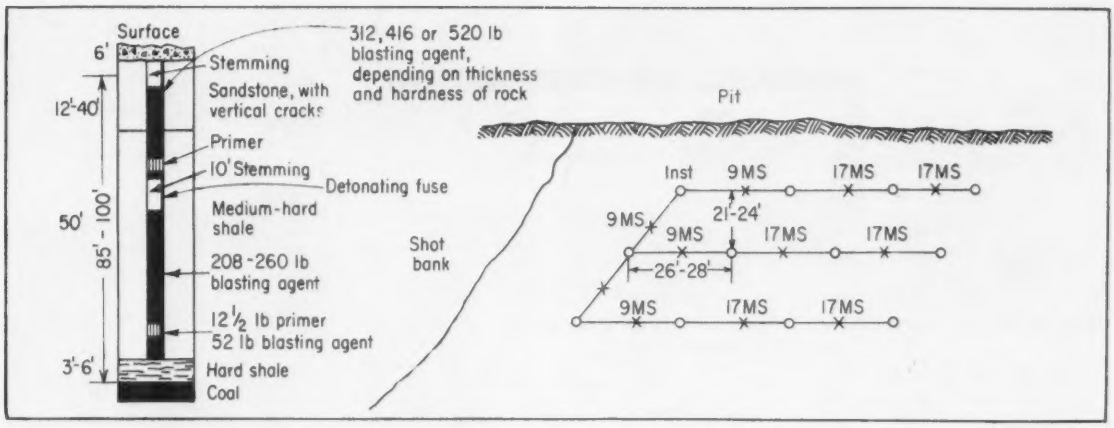
One of these special units is mounted on a wide-gage tractor, has a built-in water system for wetting the fine dust generated by the drill and a 28-ft mast that can be raised or lowered in less than 2 min. Two men drill an average of 600 ft of 7¾-in hole per shift and have drilled as much as 100 ft per hour in addition to loading explosives. Bit life averages 4,000 ft of hole (*Coal Age*, June, 1957, p 60).

ROTARY PERCUSSION DRILLING—A down-the-hole rotary percussion drill, working three shifts in an anthracite pit, sinks enough holes in hard rock to keep pace with 6- and 8-yd draglines. Water check valves between two of the drill rods prevent entry of water and dirt into the hammer if the compressed-air supply is interrupted in the drilling of wet holes (*Coal Age*, May, 1958, p 114).

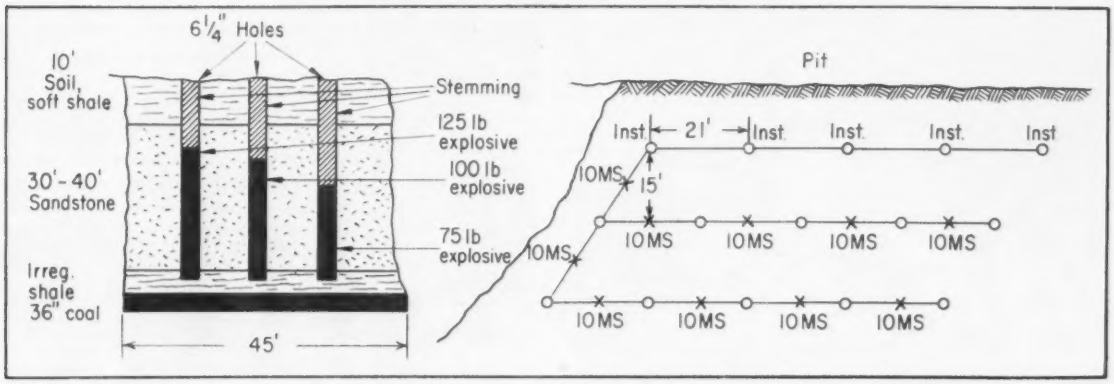
VERTICAL AUGERING — Vertical augering machines have been improved to the point where they can drill a 9-in hole in coarse-grained sandstone to a depth of 100 ft. Operating through a multispeed transmission, drill rotation can be regulated according to the toughness of the rock. Up to 600 ft of hole per shift can be drilled with this machine.

At one Ohio mine two crews use auger-type machines to sink an average of 600 ft of hole each per shift in sandstone overburden (*Coal Age*, July, 1957, p 60).

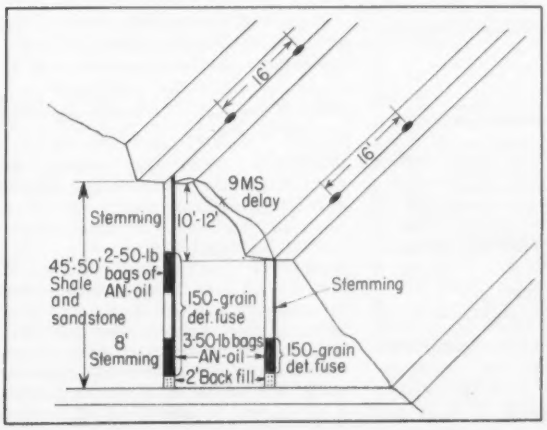
HORIZONTAL AUGERING—The horizontal sidewall drill remains a favorite for special applications and where the cover is comparatively thin, or where tough rock lies close to the coal. In some cases they are used effectively for two-level drilling in thicker cover. Special adjustable-level hydraulically powered sidewall units can be used effectively to drill near a strata whose position over the coal varies up and down.



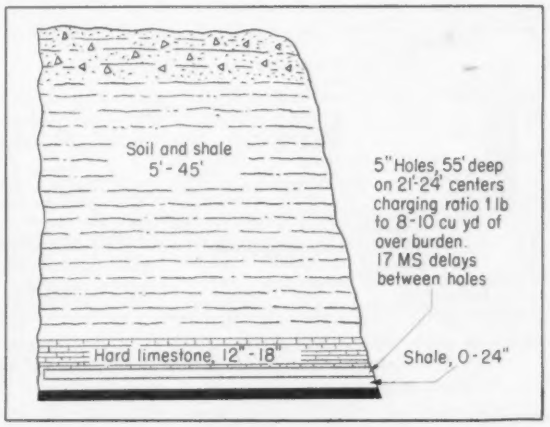
DRILLING AND SHOOTING procedures in tough rock are designed to get maximum fragmentation at lowest cost. Delays improve shooting results.



MULTIPLE ROWS of vertical holes with varying charges are effective in breaking bank composed mainly of sandstone.



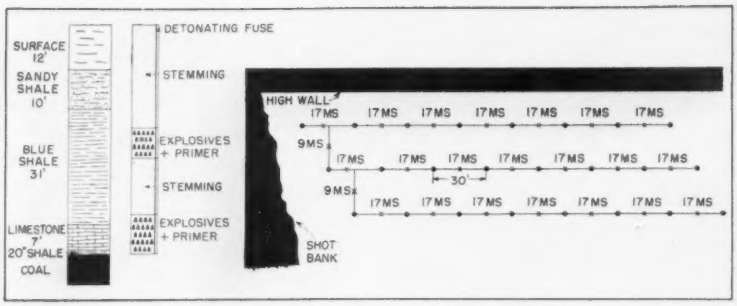
TWO-LEVEL DRILLING is a common practice in hillside stripping. Deeper holes receive heavier charge.



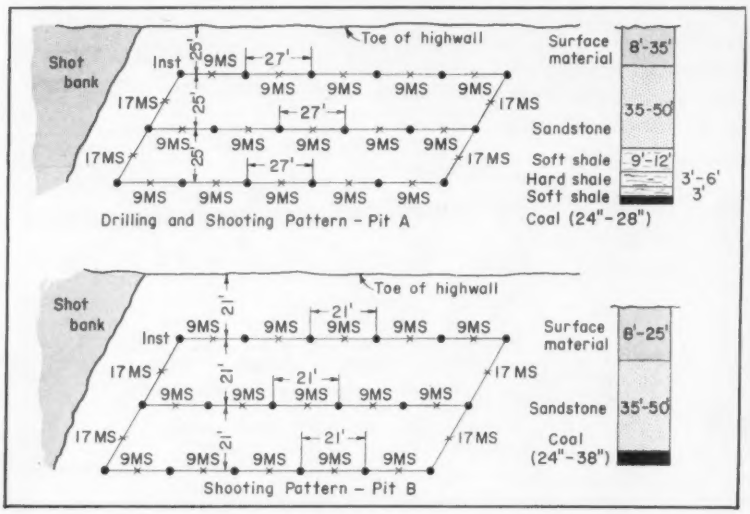
HORIZONTAL HOLES make it possible to concentrate explosives near hard layers close to the top of the coal.

They also have the advantage of easy leveling in an uneven pit. Most of the units in service today are either truck mounted or are towed on small trailers.

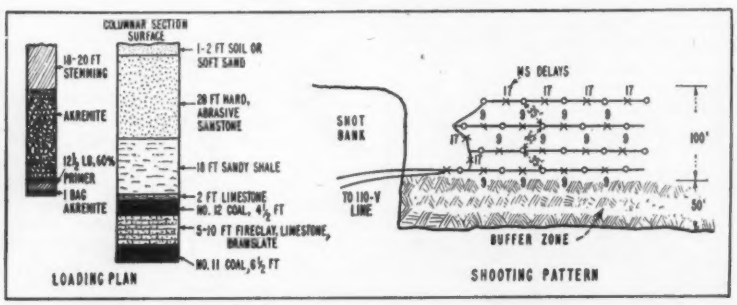
HORIZONTAL ROTARY DRILLING—To meet the need for more efficient equipment to drill hard rock fast, a horizontal rotary dry-type overburden drill now is available. One of these machines in service at an Indiana mine drills a 9-in hole 48 ft deep without adding drill sections. Penetration is 50 in per minute. Working one full and one part shift six days a week, it drills enough holes to prepare overburden for round-the-clock operation, seven days a week, of a 40-cu yd shovel. In the best single shift, 816 ft of 9-in hole was drilled by one man. Clean, smooth holes make possible loading of explosives with diameters only slightly less than the hole. Holes are reported to be straight and not to drift in the direction of rotation as auger-drilled holes do. Drill cuttings, as with vertical



DECK LOADING concentrates part of the charge in the upper portion of thick overburden for better fragmentation.



DECK LOADING is also advantageous in overburden consisting of rocks with varying hardnesses. Millisecond delays increase the effectiveness of explosives.



BUFFER SHOOTING makes possible a uniform drilling pattern, eliminates large chunks that are sometimes produced when shooting against an open face.

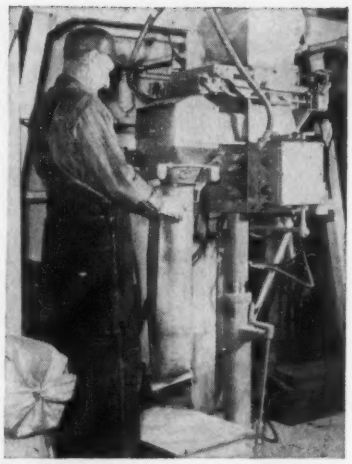
dry-type machines, make excellent stemming material (*Coal Age*, October, 1957, p 98).

Further improvements in sidewall drilling are a possibility for the near future. For example, a two-headed horizontal dry-type machine is said to be under development.

If the twin horizontal unit should prove successful several refinements in design could be added. For example, distance between drill heads could be made adjustable; a tilting device might be added so holes could be drilled at an angle; and drilling height might be made adjustable.

SPECIAL DRILLS—Where a major portion of the overburden is soft enough to be dug without previous shooting there often is the need for special units to drill a thin layer of rock over the coal, or to drill a hard rock band between two or more coal beds. A three-man crew at a western Kentucky mine uses a four-unit jumbo on a tractor to sink 2-in holes on 6-ft centers in a 4-ft layer of limestone. In average work four holes are drilled in 4 min (*Coal Age*, October, 1956, p 65).

Other machines available for drilling thin layers include single air-powered drills on hand-pulled wagons and one or two drills on the rear of a tractor.



BAG-PACKING MACHINE speeds packaging of make-your-own blasting agent.

Breaking Rock

Effective rock breaking procedures demand constant study of the overburden plus observation of field results. Charging and blasting methods must be flexible to meet changing conditions to get the most from explosives.

One type of rock might be broken best by a heavy charge in large-diameter holes spaced far apart. In other formations, smaller holes spaced closer together may result in better breakage. A combination of vertical and horizontal holes could provide the best results at other times.

In choosing the breaking medium for a particular operation, engineers and operators must consider the physical nature of the overburden, the drilling equipment available and the type of stripping equipment that will be used.

BLASTING MEDIUMS—Blasting mediums in use today include various types of high explosives; liquid oxygen; and newly developed lower-cost ammonium-nitrate-type blasting agents.

Many of the explosive manufacturers now are producing ammonium-nitrate-type or similar blasting agents. Some of these agents include the following: (1) Nitrocarbonitrate which contains technical-grade ammonium nitrate instead of commercial grade. It is not cap-sensitive, and therefore a primer must be used to set off. Speed is about 11,500 fps; (2) Unimite and (3) Methanite which contain technical-grade ammonium nitrate, coal dust and nitromethane. The nitromethane acts as a sensitizer for the ammonium nitrate and under certain conditions it is not necessary to use a primer. Speed is about 13,000 fps.

Significant improvements in manufacturing techniques have resulted in lower prices for liquid-oxygen explosives. Having a speed of 17,000 fps, this explosive has been very useful in breaking high banks containing massive sandstone.



BLOW CHARGING of horizontal blast holes offers advantages of faster, denser loading of ammonium nitrate-oil mixture.



BULK LOADER for vertical holes delivers ammonium-nitrate-oil mixture at rates up to 300 lb in 20 sec.



MECHANICAL MIXING of nitrate and oil during gravity loading is achieved with aid of electrical controls.



PORTABLE field magazines, towed to pit by tractor, ease handling of 50-lb bags of ammonium nitrate-oil blasting agent.

NITRATE-OIL MIXING — Ammonium nitrate-oil mixes continue to lead as a breaking medium for overburden. Despite the low cost of the mixture, operators are stressing more and more the need for better mixing and packaging, along with better handling in the pit.

Not only are operators becoming more interested in better mixing and handling, they also are becoming more particular in the quality of the nitrate they are buying. For example, such properties as grain size, porosity, particle strength and moisture content are being studied more closely. And research is under way to develop better mixtures of oil and nitrate.

Results of some tests show that when using straight prills, best results have been obtained with a coated product. For example, detonation velocity is said to increase as much as 10% when 2 to 3% of coating agent is mixed with uncoated nitrate before adding the fuel oil. By coating with an oil-absorbing material it is reported that mixing is easier and oil is held in closer contact with the ammonium nitrate.

Grinding all or part of the nitrate before mixing with fuel oil increases detonation velocity by as much as 1,000 fps. But the cost of handling and grinding the nitrate could be greater than the advantage gained with the faster product.

Velocity of detonation of nitrate-oil mixes increases with loading density. Loose, poured mixtures have a density of about 0.75; well-tamped and stemmed mixes have a density of over 0.9. The denser mix has a 20% faster detonation velocity. Regardless of loading density, detonation depends on using the proper primer.

Multiple primers increase the apparent velocity of detonation. By starting the chemical reaction at several points the time required for a charged hole to detonate is reduced. An added feature of multiple detonation is the greater chance for setting off the charge.

Most companies making their own blasting agent use either prilled or grained ammonium nitrate with No. 2 fuel oil. Approximately 4 qt of oil are added to each 100 lb of ammonium nitrate. Many of the larger companies have their own mixing plants where ingredients can be metered as they flow to a mechanical mixer. Some companies use the product immediately after it is packaged while others prefer to let the mixture season before using it. The seasoning period varies from several hours to several days.

Other producers prefer to mix the nitrate and oil at the hole site. Oil is poured over opened bags at each hole and then left to percolate down through the ammonium nitrate for a short period before holes are charged.

There is a trend toward using grained ammonium nitrate because it provides a blasting agent with 20% to 30% greater density. As a result more blasting agent can be concentrated in drillholes.

Some operators are using a combination of grained nitrate-oil for loading the bottom of holes and prilled nitrate-oil for the upper portion. This method of loading concentrates the blasting agent where it is needed most and makes possible wider hole spacing. There is a corresponding saving in drilling requirements.

NON-SENSITIVE PRIMERS — Non-nitroglycerine primers for use with make-your-own blasting agents are growing in favor. These primers are popular because they cannot be detonated if a shovel digs into a misfire. Danger to personnel and

equipment from this hazard thus is eliminated. A popular unit combining safety and economy is a 5-lb primer packaged in a polyethylene bag.

BUILT-IN PRIMERS — Specially packaged ammonium nitrate with built-in primer simplifies loading of horizontal blastholes while maintaining the advantage of low cost. These packages commonly come in 20- and 25-lb cylindrical cartridges, 4 or 5 in in diameter.

LOADING HORIZONTAL HOLES — When the overburden is not too thick or is not exceptionally hard, a single row of properly charged horizontal holes usually is sufficient to break the overburden. The rule of thumb in blasting with a single row of horizontal holes is to space them so that the resistance of the material above the holes will roughly equal the resistance of the material between the holes.

If the horizontal holes are placed too close together, the explosives will have a tendency to shear between holes rather than exert force upward to break the rock. As the thickness of the overburden increases, it becomes necessary to increase the hole diameter to maintain the proper concentration of explosives and not get shearing. In thicker cover it is possible to use angled holes or a combination of horizontal and vertical holes.

BLOW CHARGING — Greater loading density and a significant saving in time and effort in charging horizontal blast-holes are two major benefits resulting from the use of a blow-charging machine. Experiments at an Ohio mine show that an 80-lb bag of ammonium nitrate can be mixed with 1 gal of fuel oil in 20 sec and then blown into a horizontal hole in 10 sec (*Coal Age*, November, 1958, p 86).

At a West Virginia operation pre-oiled ammonium nitrate, half prilled and half granular is purchased in 80-lb bags and blown into horizontal holes by a truck-mounted unit. It takes about 3 min to blow 240 lb of nitrate into a hole. Each hole is primed full length of the charge with 1½ x-12-in high-velocity gelatin inserted in connected sections of tubes.

MECHANICAL TAMPING — Another device designed to reduce human effort in loading and tamping horizontal holes is the load-tamp machine. With the aid of this unit, one man in four days, single shift, does what it took two men five and six days to do. Greater flexibility in pit operations is an added benefit since blastholes now can be loaded after the seam is taken out to the highwall.

The operator's duties consist of placing the explosives and tamping bags in the collar of the hole. Using prefilled tamping bags, one man has loaded and tamped a maximum of 28 holes in a shift (*Coal Age*, September, 1957, p 88).

BULK LOADING—Bulk handling procedures are cutting handling costs of make-your-own blasting agents at several mines. One bulk loader for vertical holes consists of a storage hopper, hoist, air compressor, oil-storage tank and a measuring dispenser, all mounted on a flat-bed truck which is loaded from a 36-ton bulk-supply bin.

An air motor run by the compressor and a winch in the fore end of the truck is used for tilting the hopper to enable the nitrate to gravity feed into a 300-lb measuring container at the back end of the truck. The nitrate is admitted to the borehole by opening a butterfly valve in a 6-in drain pipe.

Actuation of the manually operated valve also operates a snap valve on an oil line through a mechanical linkage to spray a metered quantity of oil through a nozzle in the drain pipe onto the nitrate as it falls through the pipe. A drill hole can be loaded with 200 to 300 lb of mixture in 20 sec.

Another company developed a mechanical mixing system for bulk loading vertical holes. The proper mixture of oil and nitrate is obtained by controlling the gravity flow of nitrate out of a hopper and by metering oil as it is sprayed into the falling nitrate stream.

A third company solved the handling problem by developing an air-loading procedure for charging holes angled upward at 45 deg. Ammonium nitrate is poured into the storage hopper of the loading device, from which it is admitted to an air tank. As air at 35 psi moves the nitrate through a rubber hose, fuel oil is forced by air through an adjacent hose. The two meet at a junction point and flow through a pipe into the drillhole at the rate of 100 lb in 10 sec (*Coal Age*, November, 1958, p 105).

CHARGING WET HOLES—Two problems to overcome in charging wet holes with ammonium-nitrate-type blasting agents are: (1) protecting the mixture from moisture and (2) obtaining a mixture of nitrate with tht proper density so it will sink in the water.

An Ohio company solved these two problems by packaging the blasting agent in burlap bags with a polyethylene liner and using ground granules with prills to get a density of 1.16.

The mixture for wet holes, mechanically mixed in 2,000-lb lots at the company's plant, consists of 1,360 lb of prilled ammonium nitrate with a density of 0.95, 640 lb of ground ammonium nitrate granules and 85 lb of No. 2 fuel oil. Bags are filled at the plant by hand vibrating.

One-third pound of cast PETN is used as primer for each 192 lb of the ammonium nitrate mixture. It is placed inside a bag of nitrate mixture and connected to the 60-grain detonating-fuse trunk line by a short section of detonating fuse.

Several companies have found it profitable to shoot water from wet holes with explosives. For example, one company uses approximately 1 lb of PETN with cap per 5 ft of water. All holes to be shot are prepared before any one hole is shot, then the holes are fired separately.

Each hole is inspected for depth of new water before loading. If no more than 6 in of water returns to the hole, the oil-nitrate mixture is poured into the hole. If more than 6 in of water returns, cartridge powder is used up to a level above the displaced water, and then ammonium nitrate is added in the remainder of the hole. A second operation uses 4 to 8 lb of 60% dynamite per hole to blow out water.

DELAY SHOOTING — Delay shooting usually will enable explosives to do a better job. At many mines milli-second delays have been used successfully to get better fragmentation and at the same time reduce concussion in the surrounding area. Reduction of vibration is especially important where stripping is being done near populated areas.

As overburden becomes thicker, the problem of vibration and shock becomes greater because the thicker rock requires more explosives. In recent years, the MS-delay connector has become a valuable tool in reducing vibration—in many instances to about 25% of that with the usual shot.

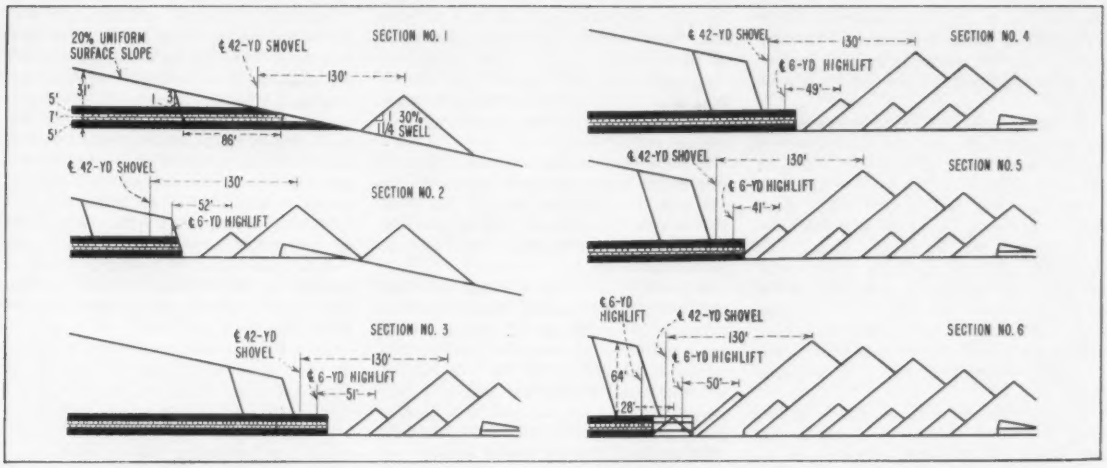
The MS connector essentially is a piece of detonating fuse with a milli-second delay built into the center. Benefits from the connectors include setting off a greater number of holes per shot with less vibration, and elimination of the hazard involved in loading a cased hole where it is necessary to charge from the drilling machine through the casing and then pull the casing up over the shunted cap wires. During this operation there is always the hazard of stray currents or a short circuit that might ground through a damaged cap wire, setting off the charge. With detonating fuse, no cap is used until this operation is completed and the machine has moved away.

A further advantage includes a 15% speedup in the detonation of the explosive with a reduction in the requirements. Fragmentation is as good and probably better with the reduced charge. Digging into misfires is not likely to result in an accidental explosion since caps are not used.

While many applications have resulted from the use of detonating fuse and MS connectors, at least one serious disadvantage of the combination is the noise and concussion caused by the detonation of the unconfined trunk line. When the shooting operation is close to populated areas, this condition presents a problem. At one mine where the elimination of noise is highly desirable, detonating fuse is used to fire the primers. Holes are shot in groups of 11, using a single instantaneous electric blasting cap and delay caps in series 1 through 10. Only a single shovelful of dirt is required at each hole to effectively cover the few inches of exposed detonating fuse and the blasting cap.

BUFFER SHOOTING—There are certain advantages to shooting against a buffer were vertical drilling is practiced. Large chunks of rock, sometimes produced when shooting against an open face are eliminated. The long toe that cannot be shot at all is eliminated. The drill never is required to work close to the highwall in an attempt to shoot a toe. A uniform pattern of drilling can be maintained because regardless of how crooked a pit is when first opened, adjustments can be made to produce a straight pit with a minimum of trouble.

Once a sufficient buffer is established to put the drill well ahead of the stripping machine, other benefits are possible. For example, in periods of dry weather the drill can be worked in areas of the highwall that would be very muddy in wet weather. And in wet weather the drill can be worked on ridges or high spots. If advance preparation of the highwall is needed for moving the drill, felled timber and brush can be pushed on to the buffer area and require no



TYPICAL CROSS SECTIONS of two-seam stripping show how 42-yd shovel with 130-ft dumping radius takes main portion of overburden on top seam and 6-yd highlift machine skims off the thin layer of rock covering the lower coal.

further rehandling prior to final disposal.

The operator of the stripping unit can widen or narrow the pit to take full advantage of the machine in the spoil area available and without interfering with the drilling and shooting. Better slopes of the highwall can be made, thereby eliminating many slides that occur when there is a high, cracked over-hang.

IMPACT BREAKING — At a western Kentucky mine recovering two 5-ft seams of coal separated by 11 ft of rock an unusual method of breaking the interval is used. The outer 25 ft of a 45-ft cut is broken with a 17-ton drop ball. The breaking medium actually is a steel billet 8 ft long, 60 in wide and 30 in thick. It is hoisted 50 ft into the air by a diesel-electric shovel converted to a crane and dropped on 6-ft centers. Cycle time is 45 sec. Excellent fragmentation is reported at a considerable saving over drilling and blasting.

BLASTING RECORDS — Good records should be kept for all blasts, including depth and spacing of holes, quantity and distribution of explosives per hole, type and thickness of overburden, feet of drilling, and cubic yards of material broken each day. When a satisfactory plan for shooting is worked out it should be adhered to until conditions change.

One company has developed an electric device that automatically records the depth of the blasthole as it is drilled. When a change of strata or a significant change in hardness occurs in the rock, it is reflected in a variation in drilling pressure. The drill operator notes depth on the indicator, as well as pressure, and records both in a log book. The record for each hole is given to the blaster to serve as a guide in charging the holes (*Coal Age*, May, 1955, p 122). The blaster can look at the hole log, tell how tough the rock is and then determine how much explosives will have to be used to get the best results. Drill-pressure indicators also show changes in the hardness of the strata and thus provide additional data for judging placement and quantity of charges.

An Ohio operator employs a blasting chart as a guide in charging holes with nitrate-oil mixture. The chart shows the proper charge for varying hole depths and centers to get the desired concentration of blasting agent. As a result of using the chart, consumption of ammonium nitrate is less and rock fragmentation is as good or better than before (*Coal Age*, January, 1960 p 83).

Stripping

Use draglines where flexibility and range are needed.

Use large shovels in area stripping where seam conditions are uniform.

Consider heavy-duty bulldozers as stripping machines in conjunction with small- or medium-size shovels.

Study the application of diesel-powered machines where frequent moves are made.

Observe machine performance to detect wasteful motions or methods.

Keep cycle time for all machines to a minimum.

Use a bulldozer or tractor shovel for cleanup work behind the stripping machine.

Keep digging teeth sharp.

REMOVING OVERBURDEN as economically as possible is the aim with any stripping machine. To move the maximum volume of material, a machine not only must operate continuously but also must make each motion perform useful work.

SHOVELS AND DRAGLINES—Shovels are available in a wide range of designs and capacities to meet most stripping conditions. For example, a 3-cu yd shovel with a 28-ft boom and 20-ft dipper handle can cut to a 32-ft height. A 45-yd shovel with a 120 ft boom and 79-ft dipper handle can cut to a height of 107 ft. The 60-yd shovel which went into service in 1956 has a 150-ft boom and can pile spoil 97 ft high. The 70-yd shovel which began stripping in 1957 has a 140-ft boom and a maximum dumping height of 96 ft 6 in.

The giant 115-cu yd shovel now under construction will have a reach of over 460 ft and will be powered by 50 motors, ranging from ¼ to 3,000 hp. It will remove 3,000,000 cu yd of overburden per month.

Draglines also are available in a wide range of sizes to meet varying conditions. A 2¾-yd dragline with a 110-ft boom can dig to a depth of 58 ft and spoil to height of 49 ft above the bottom of the bench on which it is working. A 35-yd unit with a 220-ft boom can dig to a depth of 94 ft and pile spoil 98 ft high above the tub. In between these sizes are a host of machines that can handle nearly any assignment.

Big shovels in the 33- to 70-yd range usually work to a maximum of 70 to 80 ft of cover. Removal of overburden between 9 and 50 ft thick by a 45-yd shovel costs about 45% of what it would cost to do the same job with an 8-yd shovel; in overburden between 9 to 90 ft, about 77% of the cost with an 8-yd shovel and in overburden between 50 and 80 ft, about 25% more than a 8-yd shovel working in a bank 50 ft high. Big shovels also recover coal that would be left by smaller shovels or would have to be argered or deep mined. But the area to be stripped must contain enough coal to warrant the capital expenditure for a big shovel.

Flat coal seams and steep slopes cause overburden thickness to increase rapidly as successive cuts advance into the hillside. To meet these difficult conditions, the large walking dragline is most useful because of its long dumping range. The stripping life is increased in proportion to the dumping range of the dragline, and maneuverability of the unit is advantageous in working sharp angles and inside curves. The disadvantage is that it must have a suitable base and this is sometimes difficult to provide in rocky overburden. This factor must be considered in choosing between a dragline and shovel.

BULLDOZER-SHOVEL STRIPPING — A possible combination for stripping up to 35 ft of softer material is the small shovel and the bulldozer. With this type of setup the bulldozer works across the outcrop and

takes off 10 to 12 ft of loose material—sometimes up to 20 ft. (*Coal Age*, January, 1954, p 82). The shovel is used to remove the more solid material down to the top of the coal.

At another operation in Pennsylvania two big, powerful bulldozers are teamed with a diesel-powered 2-cu yd shovel and a 4-cu yd diesel dragline to move up to 60 ft of cover (*Coal Age*, March, 1957, p 82). Each dozer works with one of the strip machines in a separate pit, two shifts per day. The bulldozers not only cut down a portion of the bank but also push a great deal of the material into the pit where the stripping units can handle it easier. They also push a large portion of the material in the spoil to a point beyond the range of the stripping units.

After a sufficient area of coal is uncovered, the shovel doubles as a coal-loading unit while the bulldozer continues to remove the top layer of cover or performs utility work. The shovel-bulldozer setup is not designed for high output but can be used effectively where cover is relatively soft and a large capital expenditure is not feasible.

Cutting down 70% of the overburden and leveling shovel spoil, a twin-engine bulldozer provides flexibility of operation at a Pennsylvania mine recovering 40-in coal. A diesel-powered shovel handles the lower part of the overburden (*Coal Age*, November, 1959, p 98).

SCRAPER STRIPPING—Conditions may change after a stripping unit has been purchased and it may be desirable to go to a higher bank, but the available shovel or drgaline may not be able to handle the overburden in one pass. Consequently, rehandling or two passes are needed. Or the unforeseen problem of a shortage of spoil area may develop and partial haulage may be necessary. Under these conditions the high-speed rubber-tired tractor-scraper has gained acceptance as an efficient auxiliary machine to move the top portion. Once loaded, the unit can haul spoil several hundred feet at little added cost. If the overburden is compacted, it is good practice to supplement the scraper units with a ripper that can be taken over the area ahead of the scrapers to break up the ground.

Scrapers, push-loaded by big bulldozers, slice off overburden in 25-cu yd bites at an eastern Ohio operation. Six units remove 1,800 to 2,000 cu yd per hour while working banks 50 to 60 ft high. Ripper-equipped tractors precede the scrapers to break the friable sandstone for the scrapers (*Coal Age*, December, 1958, p 110).

Scrapers, push loaded by big bulldozers, remove overburden on a 30- to 35-ft seam at a Wyoming mine. The stripping ratio is about 1:1 and the maximum will be 2:1 (*Coal Age*, October, 1959, p 74).

Tractor-scraper units also can be used to make an opening cut and working bench for a dragline. The number of tractor-scrapers needed for the job depends on how much of the total cover can be moved by the scraper and how much overburden must be moved to uncover the coal needed each day. For example, five tractor-scraper units aided by a rooter have removed 30 to 35 ft of cover at an operation working to a 75-ft highwall and producing 1,700 tpd of strip coal. Shovels remove the lower portion of the overburden.

A worthwhile advantage of the scraper method of handling spoil is that little extra work is necessary where backfilling and leveling are required.

In some deep anthracite pits where available draglines cannot handle overburden in one pass, the highspeed scraper has been well accepted as a primary unit in removing the top layer of overburden. Thus the dragline burden is eased.

A push-loaded scraper will load faster and will carry greater payloads because the load is heaped better and packed tighter. To get the most from scrapers, the loading area should be planned so that the units load on a down grade; haul roads should be well maintained; and the dumping area kept in good condition so the load can be released while traveling at a fair rate of speed.

Good preventive maintenance practices to follow in scraper operation include keeping good cutting edges on the scraper at all times; and holding the apron at proper height while loading to avoid damage or distortion. A misshaped apron permits load leakage on to the haul road with possible resultant tire damage. A light channel welded across the top of the scraper front end will prevent the sides from bulging and will not hinder loading.

RIPPING OVERBURDEN—The development of the hydraulically operated ripper mounted on the rear of a large bulldozer has increased the range of the scraper. The shales and soft rock that previously resisted loading by scrapers or ripping with old-type rippers or rooter are now successfully loosened. In one pass the hydraulic unit with three arms spaced at 53 in can loosen a total width of 9 ft to a depth of 12 in.

Ripping procedures vary with the stripping unit. For example, for bulldozing a minimum of passes is made to give the lowest cost. More passes must be made for scraper loading.

In general, rip as deeply as possible. Experimenting with ripping angles and depths is advisable. For scraper loading, rip in the same direction as loading.

Ripping cost compared with blasting cost must be favorable to justify its use. Under typical conditions, a 320-hp tractor with ripper can produce 300 to 600 cu yd per hour.

BULLDOZER STRIPPING—As a result of more speed and power being built into today's bulldozers, they are being used more and more as stripping units. Working in pairs or in conjunction with other equipment, they are effective in moving overburden that normally requires little or no shooting.

Where stripping is assigned to bulldozers alone, a minimum of two should work together. For efficient material handling, an average of not more than 35 ft of cover should be moved and the terrain should be gently rolling or hilly to permit easier movement of overburden. Pushing should be 90 deg with the outcrop after the initial cut is made along the outcrop and the bulldozers should work together, one following the other and slightly overlapping the path of the leading unit to pick up side spillage.

After the pit is filled sufficiently, the dozers should start pushing to the main spoil area away from the highwall. As succeeding cuts are made and the highwall gets steeper, it will be necessary for the dozers to rehandle as much as 20% of the material. To establish the highwall, the bulldozers should cut parallel to the outcrop and dig down to the coal. If hard material is met, it should be either drilled and shot or ripped fine enough so that the bulldozers can move it easily.

Bulldozers are teamed with a shovel or dragline to remove overburden in two-seam stripping in hilly terrain in West Virginia (*Coal Age*, April, 1959, p 85).

At a Pennsylvania mine operating in 36-in coal, a bulldozer with a hydraulic tilt blade takes the initial cut to within a few feet of the solid sandstone. A 6-yd diesel-powered dragline handles the remainder (*Coal Age*, September, 1959, p 106).

BOX-CUTTING—Opening a pit by box-cutting involves digging down to the coal and then working straight ahead to the limit of the property. By exercising care in opening a new strip pit along the property line in flat or gently rolling land it is possible to recover practically all of the coal in the tract. In some instances where a shovel or dragline is used to open a new tract along an adjoining property the first-cut spoil is placed on the surface next to the property line. Stripping then advances into the tract and the coal along the property line and under the first-cut spoil is left in place. Some operators do not consider it economically possible to rehandle spoil from the opening box cut and the regular material over the coal. As a result, the strip of coal along the property is never recovered. If a strip of coal 75 ft wide, 4 ft thick and 3,000 ft long is left in place along the property line, the loss will be about 37,000 tons.

AUXILIARY MACHINES — Consider the possibility of using auxiliary earth-moving equipment, such as scrapers and bulldozers to move the spoil from the opening box cut. It might be possible to start at the property line and cut down 10 to 20 ft of material with scrapers and spread it in a thin layer 4 to 5 ft thick over the surface where it can be easily handled in subsequent cuts. The scrapers could open the area by making a cut 100 to 200 ft wide along the property line. Exact width of cut can be laid out to fit into the overall plan for the regular stripping machine. It may be desirable for the auxiliary machine to cut down an area that is two or more times the width of the cut that will be taken by the shovel or dragline.

If the resulting pile is too high to be moved efficiently by the shovel or dragline when the second cut is made, a bulldozer can be teamed with it to level and spread the material in the spoil area. Or if the material is broken finely enough, it also might be possible to use scrapers effectively in the spoil area. The cost of rehandling the first-cut spoil should be weighed against the value of the coal left in place and the effect on the cost of handling overburden over the life of the mine.

STRIPPING THICK COVER — Where

extra thick cover is constantly present the big dragline is the most popular machine. However, the successful application of the 60- and 70-yd units shows that shovels can not be counted out in the thicker cover.

If only one machine is desired for stripping under consistently thick cover, the dragline usually gets the nod. Improved electrical controls and bigger motors have made it possible for the drags to work to higher banks and move more cover per hour. The result is more material moved at no greater cost than when working to lower banks. Where shovels would be working at extreme range, rehandling materials, or working in two lifts the dragline definitely offers advantages.

TANDEM STRIPPING—Many combinations of machines are removing over-burden efficiently. For example, a shovel may be teamed with a dragline in a tandem operation. In this type of set-up, the drag works ahead, taking the upper section of the overburden and leaving the remainder for the shovel. The percentage of material to be handled by each unit depends on the capacity of each and the stripping conditions.

Various other combinations are being used in tandem operations. Where there is a fairly thick layer of soft material at the surface, tractor-scrapers and bulldozers can work on the highwall and cut down a sizable portion of the overburden. Auxiliary equipment also can be used effectively on the spoil pile to permit stripping units to work to higher banks. Where auxiliary units work on the spoil bank, they frequently do a great deal of leveling so that final reclamation or backfilling is not too costly.

MULTIPLE-SEAM STRIPPING — Two or more seams close together frequently can be mined profitably where one alone would not be profitable. The choice of equipment and the mining method depends on the dip and thickness of the coal; the topography of the land; and the type of rock above and between the coal beds.

In anthracite mining, multiple seam stripping usually is on the pitch. Overburden may be moved by any of the standard types of stripping equipment, including draglines, shovels and draglines, or shovels alone. Spoil haulage is common practice.

Where there are flat or nearly flat seams, overburden can be moved by a specially designed shovel (*Coal Age*, August, 1954, p 64); two draglines plus an auxiliary shovel (*Coal Age*, July, 1955, p 56); or a shovel and dragline (*Coal Age*, January, 1953, p 84). The choice of equipment in each case was made to get the best results under the conditions.

The specially designed shovel strips two seams simultaneously from one position in gently rolling country. Both seams are thin and are separated by 16½ ft of rock. Working on the lower seam, the shovel uncovers a 50-ft strip on each level while working to banks up to 60 ft above the upper seam.

The two draglines and auxiliary shovel are used in flexible setup in gently rolling country to mine two seams separated by 3 to 10 ft of limestone. Where banks range between 50 to 70 ft in thickness, the two draglines work in tandem, and where cover is thinner they work separately. The limestone interval between the two seams is drilled with percussion units and the broken material is cast to the spoil area by the coal shovel on the off shift.

The shovel and dragline were teamed to mine two seams separated by about 40 ft of rock in hilly country. Operating procedure is to remove the lower seam back to the outcrop of the top seam, using the shovel to make a working bench for the dragline which completes the cut. Next the shovel removes part of the cover and makes a bench on the upper seam for the dragline, which strips to a 40-ft bank. After this coal is removed, augering is done to complete mining in the upper seam. The next step is to recover the lower seam, leaving a 90-ft highwall. Augering to a depth of 175 ft in the lower seam is the final stage in mining at this property.

An eight-step system for contour stripping and augering makes it possible for a West .Virginia operator to remove 95 ft of overburden while recovering 13 ft of coal from two seams. A vertical overburden drill, 8-yd dragline and two highwall augers are key machines in producing 200,000 tons per year (*Coal Age*, March, 1958, p 90).

Another West Virginia operator recovers four coal beds totaling 16 ft and spaced within a 60-ft vertical interval in a highly flexible operation demanding close supervision. A 5½-cu yd shovel is the major stripping machine (*Coal Age*, August, 1956, p 88).

THE WHEEL EXCAVATOR — The wheel excavator has been developed for use in the United States to cut the cost of moving material in 50- to 85-ft highwalls. The three objectives in using the machine are: (1) to handle overburden up to 85 ft thick, and place the spoil far enough away to avoid slides; (2) to cut the cost per cubic yard below that possible with conventional machines of equal size and capacity; (3) to leave any overburden not moved by the machine so low in height that capacity of the accompanying shovel or dragline will be increased.

WHEEL EXPERIENCE—Operating experience with the latest American wheel excavator at an Illinois mine demonstrates that they can dig 3,500 cu yd of overburden per hour and deposit it over 420 ft from the digging point. While operating 80% of the time, the wheel moves 2,000,000 cu yd per month. It can dig from 9 to 100 ft above the coal and spoil at a maximum height of 119¼ ft (*Coal Age*, August, 1959, p 82).

A significant saving in drilling and blasting cost is possible with the wheel excavator where it can be used. For example, one Illinois operator was able to shorten blastholes by 30 to 40% while eliminating the problems of hole squeezing and casing through sand. At the same time bit cost was reduced considerably.

At another wheel operation, a wheel strips and spoils 10,000 cu yd per shift, moving 25-30 ft and leaving 30-35 ft for a 33-yd shovel (*Coal Age*, July, 1956, p 60). Cuts taken by both machines are 45 ft wide, but the wheel-excavator cut is offset from 10 to 15 ft from the shovel cut to provide a bench that prevents spillage of the softer top material into the uncovered coal where the shovel would be required to re-handle it.

The narrow bench left by the wheel provides another advantage since the shovel can work to a nearly vertical face on the lower bench, instead of having to shape a sloping highwall to prevent sloughing of the softer top material.

Further improvements in wheel design to increase versatility and usefulness are possibilities for the future. For instance, serious consideration is being given to making changes that would enable the wheel to work on a bench much like a dragline when operating in tandem with a shovel. To make it possible for the wheel to be brought up out of the pit to the bench, one design change being considered is independent rotation of the digging boom so that the discharge boom could remain in a fixed position to transport material to the spoil area.

With the wheel operating from the bench it might also be necessary to lengthen the discharge boom to compensate for the greater distance the wheel would be working from the spoil area. Another possible refinement in wheel design would be to provide independent rotation for the discharge boom for even greater flexibility of operation.

HAULING SPOIL—Whenever possible, thick cover should be removed by casting. However, there are limiting factors, such as, spoil area available and range of the stripping unit. If the coal seam lies flat, is of average thickness and brings only an average sales price, it usually is not profitable to haul spoil. But if the coal is steeply pitching or is extra thick and the sales price is high enough, spoil haulage is feasible as a means of increasing the stripping range. Spoil haulage is most common in the anthracite area and is being carried on to a lesser degree in the bituminous.

Rugged, high-powered, end-dump trucks lead in spoil haulage, with tractor-scrapers and rock wagons moving a respectable portion of the material.

PIT CLEANING—Since the goal in stripping is to keep the stripping unit working at full capacity, pit cleanup should be left for auxiliary machines. Rubber- or tractor-mounted bulldozers are widely used for this work, along with the motor grader. The money invested in an auxiliary cleanup machine and its operator is justified by the increase in output of the stripping unit and a corresponding boost in available coal.

Although it pays to have an auxiliary machine clean the top of the coal, the stripping unit should take time to trim loose material on the highwall rather than leave it for the coal-loading shovel. Furthermore, it may be impossible for the coal shovel to reach the loose material and because of the hazard some of the coal will have to be bypassed until the next cut is uncovered. This procedure will result in a ragged pit and possible loss of coal.

Operating Stripping Machines

THE KEY to efficient performance of stripping units is keeping machine productivity as high as possible. The time spent in loading, swinging, dumping and returning for a new load must be kept to a minimum.

A fully loaded dipper should be the goal in each cycle. To help analyze machine performance, some companies rely on recorders that indicate work time, angle of swing and the number of swings per shift.

A well-prepared bank makes possible fast loading and the finer the material the faster it can be loaded. But there is an economic limit to the amount of money that can be spent for explosives to break the rock. The type of overburden and the type of stripping unit are important in deciding how much explosive can be used.

IMPROVING DRAG LINE EFFICIENCY—Proper working of the digging face offers the best opportunity for achieving maximum production from a dragline with a minimum of power consumption and wear and tear on the machine. Slicing material off in layers will give more output than working in trenches. However, a "key" or trench cut along the highwall line frequently will ease the rest of the work. The dragline bucket should be loaded as quickly and hoisted as nearly vertically as possible to keep power consumption at a minimum. Poor operation, such as digging on a slope near the machine and lifting the loaded bucket approximately 45 deg with the vertical may consume up to 42% more power.

Quick loading and immediate hoisting will move the most yardage. By keeping the digger area under the boom, dividends will be reaped in greater output. The bucket should be filled while traveling two or three bucket lengths and then hoisted immediately. Every effort should be made to get a full bucket in the short travel but if it is not completely filled, it is best to lift and swing the load. By hoisting the bucket as soon as it is loaded, dirt pileup in front of the machine will be avoided and the danger of drag rope wear will be eliminated.

Sidepulling with the boom over-heats and wears swing clutches, puts unnecessary wear on the flanges of the boom-point sheave and may result in a twisted boom. This should be avoided to keep maintenance down.

ENGINEERING ANALYSIS—Industrial engineering techniques are being applied more and more to help mine management increase operating efficiency. And this practice is becoming more widespread in strip mining. A time study method designed for stripping shovels can be very simple, but the benefits can be large.

To get the most from a shovel time study, conditions under which the unit works must be studied carefully. Shovel performance can be affected directly or indirectly by width of coal pit or strip pit, width of haulage berm, water in the pit, haulage units and depth of overburden.

The type of overburden and how easily it can be dug is especially important. A series of time studies and a careful analysis of the results will show when the most economical point of overburden preparation has been reached.

RECORDER STUDIES—Time studies for shovels can be divided into two types. The simplest is a daily record of how many swings the machine makes and the length, in degrees of arc, of each swing. This information is obtained automatically by mounting a recording device, sometimes called a swing recorder, on the shovel. This device has a spring clock which pulls a roll of graph paper past a moving recording needle. The recording needle is synchronized with the movement of the machine's swing gears and records each swing on the roll of graph paper.

This type of study indicates when no useful work is being done—a straight line appears on the recorder roll. To provide management with information on these delays, shovel operators should be given daily delay forms on which to check off the cause. If these forms are designed properly, all the operator need do is place an X in the proper place to pinpoint the cause of the delay.

From the recorder sheet and the operator's delay sheet, engineers can make a complete report of how much time was spend digging, how much time was lost in delays and the number of swings.

BUCKET MAINTENANCE — Proper handling on the job, coupled with good maintenance procedures, will keep bucket maintenance to a minimum. Among the bad operating practices to avoid are striking the bucket against a solid object to loosen sticking material; dropping the bucket, especially with the teeth down; slapping the bucket against the boom while hoisting; and pulling the drag-bail socket into the fairlead.

Bucket teeth take a beating and must be kept sharp for good digging. Spare sets of teeth should be kept on hand for frequent changing so that worn units can be built up with hard-surfacing materials. Under no conditions should teeth be permitted to become badly worn.

Small cracks develop in the bucket from time to time as a result of accidental abuse. These weak spots should be repaired as quickly as possible to prevent big repair bills later. Many companies find it profitable to buy a minimum of two buckets for each dragline so that bucket maintenance can be done on the regular work shift without reducing dragline output. When repairs are needed the bucket is changed on the off-shift, or with a minimum of delay if the dragline works around the clock. Two buckets kept in good condition and used alternately will last longer than buckets bought one at a time and used continually until worn out.

SHOVEL OPERATION—As with dragline loading, the bank should be removed in slices in shovel work. The thickness of the slice should be such that the dipper will be filled as it reaches the top of the bank. It is usually good practice to dig the top half of a high bank first. This method keeps sloughing into the pit to a minimum and avoids lowering of the dipper to the bottom each cycle. Consequently, cycle time is speeded up and output is increased.

Load indicators are also gaining in favor to show the operator when the dipper is fully loaded and ready to be hoisted (*Coal Age*, October, 1953, p 80). The operator can be trained to hoist and swing as soon as a full load is indicated on a meter in his cab rather than relying on personal judgment. An indirect benefit from load indicators is less overloading and therefore fewer breakdowns.

Short moves should be made to maintain an efficient digging position. Digging beyond the boom point should be kept to a minimum. When working with too much reach, too much time is lost crowding and retracting. Sweeping the dipper back and forth to level off spoil causes side strains and wear on the boom, dipper stick and dipper.

Augering

Since the highwall auger was introduced to the industry, it has grown to the point where it is producing in the neighborhood of 10,000,000 tons a year. When teamed with stripping equipment, such coal-recovery drills have permitted stripping to be done to higher banks. The combined cost of auger coal and strip coal from the higher bank can be made to equal or better the cost when stripping alone is done under thinner cover.

Coal produced by augering usually is dry, clean and has a good proportion of lump sizes. However the proportion of lump usually decreases as the augering depth increases. Where the seam has a layer of high-ash coal on top of it, selective mining can be practiced and clean coal produced without preparation.

Augers are available in diameters ranging from 16 to 52 in, and are capable of producing as much as 800 tons of coal per shift. To increase flexibility in operation, augers are available with conveyors that permit coal to be discharged on either side of the unit.

A three- or four-man crew usually handles all the work involved in the augering and is supplemented by a group of truck drivers.

PREPARING FOR AUGERING—If augering is to be done as part of the stripping operation, make preparation as stripping progresses. Care should be taken in blasting so that the highwall will be left in the best possible condition. A highwall slide can endanger the lives of men or result in serious damage to the auger as well as cause a loss in production.

A clean well-drained pit of suitable width for auger operation should be left as stripping progresses. It is much more economical to anticipate the use of the auger and make the necessary preparations as part of stripping than to do it later. It also is desirable to auger as soon as possible after stripping is completed and while the highwall is in the best condition. If there is coal remaining beyond the augering limit, solid blocks of coal should be left at regular intervals to permit access for future deep mining. The size of block to be left depends upon the thickness and type of cover, the thickness and the strength of the coal, and the mining laws.

AUGERING METHODS—Augering usually is done by drilling single holes to the desired depth with a unit that takes nearly the full seam height. However, for seams more than 5½ to 6 ft thick, it is best to use a smaller auger and double drill, preferably overlapping the bottom hole into the top. Staggering top and bottom holes is another method.

The depth to which augering is carried out depends to a great extent on the coal thickness, whether the seams roll or are flat, and whether they are strong enough to stand after penetration and not foul the auger. Distance between holes also depends on the strength of the coal and the overlying rock.

AUGERING EQUIPMENT—Equipment requirements for augering depend upon the application. For example, if the auger works in conjunction with stripping a bulldozer and trucks will be the only additional equipment that will be needed. Service and maintenance trucks used for the stripping equipment can take care of the auger. If augering is done independently of stripping, either in abandoned strip pits or in areas where no stripping was done a small shovel and service facilities probably will be needed. The shovel will be needed to provide a working bench along the outcrop or help the bulldozer clean old pits.

AUGERING RESULTS — At one West Virginia operation where a 48-in auger recovers 40 tons per shift, three men perform all the work connected with augering. One man operates a bulldozer to move the auger to new drilling sites and to clean the pit in the augering area. The other two men operate the auger and add or remove auger sections.

A crew of four men produces 140 to 150 tons of coal per shift with a 30-in self-moving auger that bores holes 125 ft deep in an Alabama pit. Three men remain in the pit and the fourth drives loaded trucks to the preparation plant. One truck serves as a surge bin while the driver makes a round trip to the plant with the other.

A self-moving 47-in unit works in a mountaintop pit only 26 ft wide. Self positioning with three hydraulic positioning jacks make it possible for the unit to be moved fast and easily to a new hole site.

Three augers, two full time and one spare, are used at this property to recover coal that could not be stripped because of the hazard of spoil rolling or sliding downhill and damaging vital mine installations (*Coal Age*, September, 1956, p 72).

In Ohio, a 30-in self-moving auger produces 400 to 500 tpd in three-shift operation. Working in areas previously deep mined, the unit has produced up to 275 tons in a single shift (*Coal Age*, July, 1957, p 60).

Production of 150 tpd with six men, including truck drivers, is achieved with a 24-in auger. The company uses trucks for overnight storage to get full-shift operation. Four trucks are used regularly by the two drivers. While they shuttle back and forth between the pit and cleaning plant, the elevator operator spots empty trucks. When a truck is filled it is driven from under the elevator and parked headed toward the preparation plant. When a driver returns with an empty truck there is a loaded one waiting for him (*Coal Age*, December, 1956, p 54).

New entries in the auger group are the twin-head and triple-head machines capable of boring two and three holes at the same time. The units break out the small pillar between the holes and thereby increase recovery. Capacity is boosted and as a result, thinner seams that previously could not be mined profitably now may be recovered.

Coal Loading

Balance coal loading capacity with stripping capacity.

Employ auxiliary machines, such as tractor shovel, bulldozer, motor grader or power broom, to clean the top of the coal before loading. Resort to hand cleaning where power units cannot remove impurities from irregular seams.

Consider special machines for loading thin seams or for selective loading of split seams.

Study breaking methods to speed loading of hard seams.

BREAKING COAL—Where the coal is of average thickness and hardness explosives used in breaking the overburden usually will loosen the coal sufficiently so it can be loaded easily without being blasted. But sometimes it is too hard to be broken this way or the nature of the overburden may prevent it.

At other operations, it is necessary to drill and shoot the coal in a separate operation. Self-propelled combination machines made up of drills, compressors and brooms are frequently used for this work. Either one or two drill arms are mounted on these units to put down holes in a minimum of time. The power broom is used to sweep the top of the coal before holes are drilled and is disengaged from the power unit during the drilling cycle. Sometimes a handpulled wagon with a gasoline-powered drill is satisfactory.

RIPPING COAL—Breaking coal with a tractor mounted ripper is proving an effective and economical aid in keeping cost to a minimum. This technique is made possible by the recent development of large hydraulically controlled rippers mounted on the rear of tractors having engines with more than 300 hp. Unlike former towed rippers which simply trailed the prime mover and exerted no down pressure, the tooth of the mounted ripper concentrates the entire weight of the tractor for maximum penetration.

With tractor weights approaching 70,000 lb, only the tractive effort of the prime mover and the size of the tooth limit the depth of penetration. Ability of the modern tractor to develop up to 54,000 lb of pull at the drawbar makes riping possible in seams up to 6 ft thick. In an Illinois mine, a tractor-mounted ripper with an 8-ft tooth breaks a 4½-ft seam of coal at a saving of $42,000 per year over conventional methods. (*Coal Age*, February, 1958, p 148).

Riping a 3- to 6-ft layer of shale on top of the coal and then the coal results in greater coal recovery and a reduction in the quantity of fines and large lumps going to the preparation plant at a western Kentucky operation. Only 45 min is required to rip enough coal for an entire shift of loading. The decrease in fines going to the preparation plant lightens the load on the wet tables and crusher, making it possible for the plant to handle more coal (*Coal Age*, January, 1959, p 82).

COAL CLEANING—Preliminary cleaning before loading, where desirable, can be done by tractor-scrapers, bulldozers, graders, rubber-mounted scoop loaders or power sweepers. If there are any clay veins in the coal or the top of the coal is very irregular, it may be necessary to remove part of the dirt by hand. Hand cleaning, however, is expensive and should be avoided where possible.

LOADING METHODS—First consideration in choosing a coal-loading machine is to match its capacity to the ability of the stripping unit to uncover coal. Sometimes it is desirable to have excess coal-loading capacity so that any time lost by transportation or tipple delays may be partially regained by faster loading. By loading trucks rapidly with an oversize shovel haulage can be restored to normal in a minimum of time.

SPECIAL SHOVELS—If the coal seam is thin, consider the horizontal-thrust shovel or the skimmer unit, either of which moves the dipper parallel to the bottom where loading. These units have the advantage of scooping up a wide channel of coal without disturbing the bottom.

SPECIAL DIPPERS—If the coal seam is split into two or more parts by several feet of rock, the specially designed dipper on a conventional shovel may work out better. The top layer of coal can be scooped off and then the same shovel can be used to remove the rock covering the lower portion of the seam. If the coal loader cannot be spared for the rock job, the regular stripping unit can be used on the off shift to remove the thin layer of rock.

When the coal is more than 2 or 3 ft thick, but is extremely hard, a divided dipper can be used effectively to limit the size of lump that is delivered to the truck and therefore to the preparation plant.

To minimize spillage when loading the top seam into trucks on the lower seam, a special variable-rake-angled dipper was developed. The dipper is set for the proper rake angle for digging, then when raised for dumping the angle is readjusted through a control in the operator's cab to the proper angle for low dumping. Afterwards the rake angle is reset for digging.

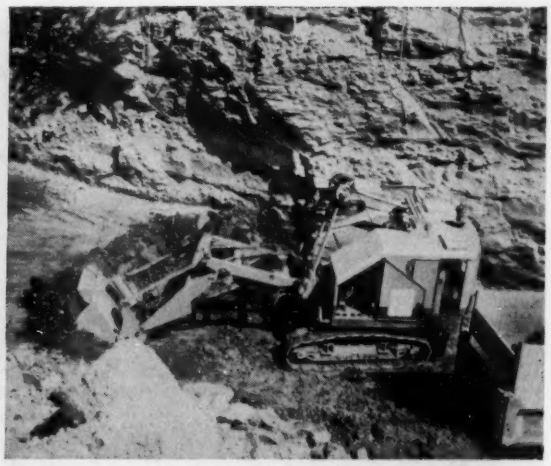
STOCKPILING—Where two-shift operation of the preparation plant is not desirable and the coal is thin, top efficiency from the loading and hauling units can be achieved by heaping the coal to one side of the pit on the off shift so that loading-time will be as low as possible on the regular shift. The loading shovel thus can fill a truck faster and coal will be carried to the tipple faster.

INCREASING COAL RECOVERY — The importance of recovering all the coal that is uncovered cannot be over-emphasized, particularly where the seam is thin. If by careless operation of the coal-loading shovel 3 in of coal is left on the bottom over an area of one acre, the loss will be about 450 tons. If 10 acres of coal are stripped in a month, the resulting total loss will be 4,500 tons. At a sales price of $4 per ton, this amounts to $18,000 per month.

If working completely to the bottom results in much overshooting or in too much



REDESIGNED SHOVEL with longer boom and dipper stick and "conning" tower for operator loads lower seam into trucks traveling on upper seam.



HORIZONTAL-THRUST LOADER skims off the top layer of coal without disturbing fireclay parting. Equipment of this type is especially adapted to trim coal.

loss of time, and there is considerable coal involved, a bulldozer may be assigned to accompany the loading shovel. It can rip up the bottom coal and keep it pushed up to the loader with a minimum of digging into the bottom and at a cost still representing a considerable saving over leaving the coal or delaying the loading.

If a washing plant with sufficient capacity is available some bottom material can be tolerated with either shovel or bulldozer cleanup. If a washer is not available, more care is required, but it still is possible under many conditions to increase recovery without undue contamination.

Another place where good loading procedure pays off is along the outer edge of the coal where it is in contact with the spoil. If a 6-in strip of coal is left along 1 mi of a seam of coal 60 in thick, the loss will be about 528 tons of coal. At $4 per ton, this will be $2,112.

To provide a solid vertical edge and prevent losses such as this, one company developed a marking machine that shears through the coal, marking the loading limit for the shovel and leaving a smooth vertical wall on the bench. Estimated savings were about 200 to 400 tons per acre.

Transportation

Fit truck size to loader capacity and pit dimensions.

Consider alloy steel or aluminum for truck bodies to increase payload per trip.

Investigate hydraulic retarders for controlling truck speed on long downgrades.

Consider torque converter transmission for trucks operating on steep grades.

Study the possibility of combining truck and rail haulage where the haul is long, the topography favorable and the reserves ample.

Provide good alignment and grade for haul roads. Practice regular surface maintenance, including sprinkling in dry weather, to help minimize truck maintenance.

SELECTING TRUCKS—Choosing the largest available unit does not always result in a lower haulage cost per ton because final truck selection is based on many factors including production, pit width, types of roads, grades, distances and size of loading shovels. Wherever possible, the size of the haulage unit should be matched to the capacity of the loading shovel. For example, a 5- to 7-yd shovel works well with a 40-ton truck and a 3- to 4-yd shovel teams well with a 25-ton hauler. A good rule of thumb is to use trucks with four to five times the dipper capacity of the shovel.

Overall height of the truck should be such that it makes a good target for the loading shovel. Length should be minimum and width a maximum so that the shovel loading cycle can be kept to a minimum. Ability of a truck to turn around in cramped quarters in as short a time as possible and get under the shovel without delay should be considered to avoid traffic congestion.

Coal-hauler size runs up to 50 tons in anthracite, and up to 80 tons with tractor-trailer units in bituminous. Power is supplied by engines up to 450 hp. In recent years trailer weight has decreased, and payload and speed have increased by 25 to 30%.

TRUCK DESIGN—New ideas constantly are being introduced in truck design to increase payload or improve performance. For example, tractor-trailers now in service at an Illinois mine feature a tractor that has no front axle. Instead wheels are mounted individually on a spindle which in turn is fastened to a hydraulic shock absorber. The suspension units act as giant kingpins and support the front wheels while making it possible for them to be steered. Two of the units replace the front axle, two are used to spring the drive axle and two support the trailer axle.

With few minor changes, one is also used to connect the trailer to the tractor. One advantage of this type of connection is that the loaded trailer is carried on a cushion of air; hence, shocks are absorbed by the connecting member rather than transmitted directly to the tractor. Another advantage is that the connection is located 30 in ahead of the centerline of drive axle and thus gives capacity loading of the front axle.

A special airplane-type propeller cooling fan is used on the engine, saving 66⅔% in the power required for cooling. Controlled thermostatically, the fan runs only when engine temperature is above 190F.

The use of alloy steel for fabricating trailers capable of carrying 80 tons of coal results in more payload per trip. Other improvements in design make it possible for the unit to carry 4.4 cu yd per foot of trailer compared to 2¾ cu yd in a conventional trailer.

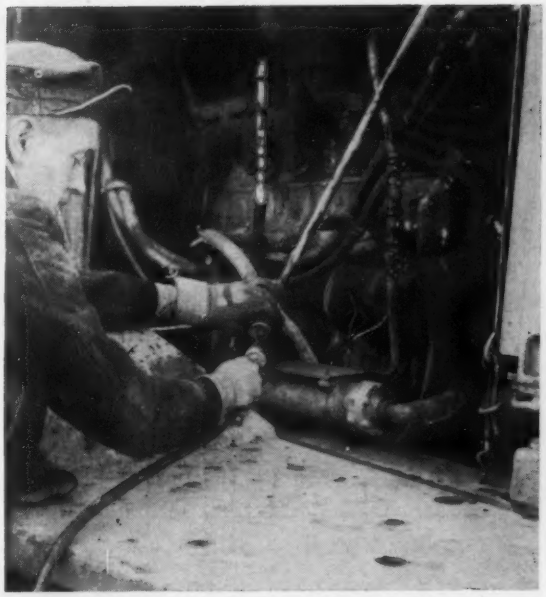
TORQUE CONVERTERS—Torque converters make for smooth truck operation, less lugging and lower maintenance. They also have made it possible for loading trucks to climb steep grades, thus shortening haulage routes. In some cases, a 48-ton truck with torque converter can haul coal at up to 30% less per ton-mile than a 37 ton truck with a standard transmission on the same route.

AIR STARTERS—Air starters have been used effectively on large coal haulers to eliminate all batteries except the 6-V units for headlights. Starters are operated by compressed air supplied at 100 psi from a storage tank on the tractor. Trucks can stand idle for 4 or 5 days and there still is enough air in the tanks to start the engines.

HYDRAULIC RETARDERS—Hydraulic retarders are available for controlling the speed of trucks on long steep downgrades. The unit also acts as a governor. Mounted on the drive shaft of the truck, the device is designed so that when the shaft speed increases, the retarder resistance automatically increases at a much faster rate. Therefore any tendency of the truck to run away is curbed by the retarder which piles up resistance very rapidly when the truck's speed tends to increase. A control valve near the driver regulates the degree of braking available by controlling the oil passing

Fuel Oil Selection Chart

Type of Engine Application	Ambient Air Temperature	Distillation — 90% Boiling Point (Max.)	Distillation — Final Boiling Point (Max.)	Cetane Number (Min.)	Sulfur Content (Max.)
Wide variation in load and speed, considerable idling.	Above −20 F	550 F	575 F	45	0.25%
	Above 0 F	575 F	625 F	45	0.50%
	Above +40 F	575 F	625 F	45	0.50%
	Above +80 F	625 F	675 F	40	0.50%
Intermediate load and speed, minimum idling.	Above −20 F	550 F	575 F	45	0.25%
	Above 0 F	575 F	625 F	45	0.50%
	Above +40 F	625 F	675 F	40	0.50%
	Above +80 F	625 F	675 F	40	0.50%
Heavy load and high speed, minimum idling.	Above −20 F	575 F	625 F	45	0.50%
	Above 0 F	625 F	675 F	40	0.50%
	Above +40 F	625 F	675 F	40	0.50%
	Above +80 F	675 F	725 F	40	1.00%



ELECTRIC ENGINE HEATERS simplify cold-weather starting of 335-hp engines on 51-ton coal haulers.

into the retarding device. Aside from slowing the truck, the device is said to save tires, fuel, time and brake lining.

ENGINE HEATERS—Cold-weather starting of truck engines is simplified at an Ohio mine by electric engine heaters. Each engine has its own electric heater which has an aluminum jacket enclosing a 2,500-W heating element. It is permanently installed in the engine's cooling system.

At the end of the shift each driver parks his 51-ton coal hauler beside the shop and connects the heater to one of the all-weather outlets mounted on the outside of the shop wall. The heater keeps the engine water temperature at about 120 F. As a result, little or no difficulty is experienced in starting the engines in sub-zero weather.

TRUCK-RAIL HAULING—Where the haul is over 3 or 4 mi, the topography is favorable and sufficient coal reserves are available, the use of a field station and rail haulage to the preparation plant is worthy of consideration, particularly since the advent of the small diesel locomotive. With this type of setup one man can load a trip of cars, haul it to the preparation plant, dump it and return to the field station in a minimum of time. A minimum of trucks are needed to shuttle back and forth between the pit and the field station. Consequently, truck maintenance costs also are lower and fewer men are needed for operating and servicing trucks. A further advantage is that road maintenance will be lower.

OVERLAND BELT—An added starter in the transportation field is the overland belt system that carries coal from portable bins near the pit to the cleaning plant (*Coal Age*, August, 1954, p 64). Where the land is gently rolling and stripping can be carried out in a wide area, the overland belt offers the following advantages:

1. Eliminates the cost of building and maintaining long, high-speed haulage roads.
2. Permits movement of larger tonnages with fewer or smaller trucks.
3. Permits recovery of belt after the property is worked out. Roads cannot be recovered.
4. Reduces the manpower required for maintenance of trucks.
5. Requires a smaller supply inventory and less garage space.

Road Building

Main roads should be built with wide beds and have good alignment to permit trucks to run at top speed. All curves beyond the gentlest should be super-elevated.

Roads should be planned well in advance and when fills are needed to get the proper grade, they should be built up well ahead of the time they are needed. Fills should be compacted as they are made and topped off with one or more feet of rock that will serve as a road base. After this material is compacted, a top layer of crushed rock should be added and compacted. This top layer usually is applied in several layers and compacted between each. Material used for the top layer includes Nos. 3, 4 and 6 crushed limestone, 2-in slag or red dog.

SURFACE MAINTENANCE — One or more road graders, depending on the length of road to be maintained, are used at most operations to keep the running surface smooth. Roads should be sprinkled regularly during the dry, dusty season not only to maintain good visibility but also to keep dust out of truck engines and moving parts, thus helping to reduce maintenance.

EFFECT OF GRADES—Grades should be avoided as much as possible to keep power requirements down. For example, it takes twice as much force to move a 20-ton load up a 5% grade as on the level. Where grades must be negotiated, stepped-type roads can be used to advantage. This type of road involves alternate stretches of level road and short comparatively steep rises. Therefore less cluching is required in trucks equipped with standard transmissions and there is less lugging on the up grade and over-speeding on the down grade. Constant shifting and lugging results in reduced life for engine, transmission and clutch.

Entrances to the pit should be one way if possible. Turning and backing large haulage units takes time and thus reduces haulage efficiency. Proper design of turn-ins can eliminate this problem.

SNOW REMOVAL — In winter, roads should be cleared of snow before trucks start to operate. This will prevent formation of slippery conditions caused by compacted snow. A motor grader, started several hours before trucks begin to travel, should be able to clear an average snowfall. If there is a severe storm, bulldozers should be added to help move the snow off the haulage roads.

Power

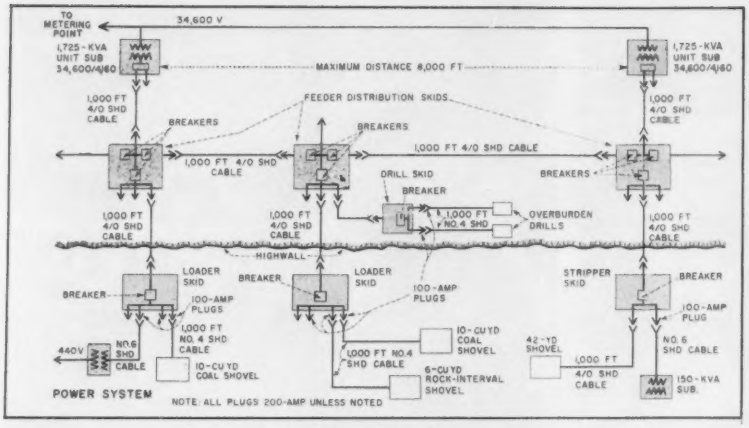
Buy power at the highest voltage feasible to get as favorable contract as possible.

Provide adequate protection for men and machines against ground faults.

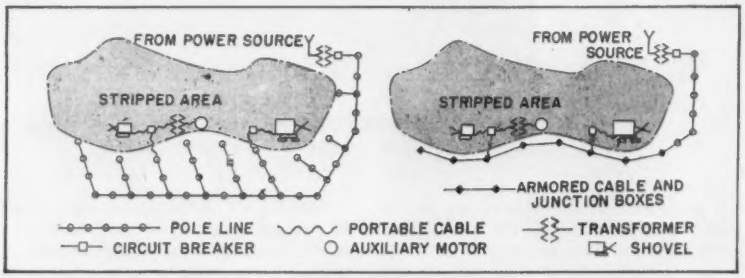
Employ Type SHD cables for portable service, preferably in 1,000-ft lengths.

Study parallel operation of portable substations for large operations.

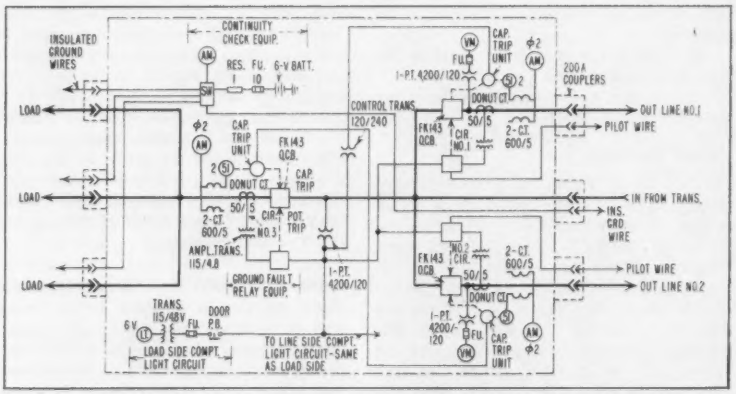
Investigate less expensive special-type



HOW power is distributed in loop system that has two easily moved skid-mounted substations plus portable auxiliary units.



POWER distribution systems at today's strip mines include both lateral pole lines and armored cables.



ONE-LINE DIAGRAM of triple-breaker skid shows how ground-fault and continuity-check circuits are built in.

mine power cables for exclusive use between breaker skids along the top of the highwall.

Set up a cable maintenance program, and provide equipment for testing and fault finding.

IN LAYING OUT a distribution system, three primary factors are involved. First, the system must be able to supply the equipment without objectionable voltage regulation from an operating standpoint and at the same time stay within reasonable economic limits. Second, the system must provide adequate protection for personnel and equipment. Third, the units in the system must be adaptable to relocation to keep up with the change in the load requirements.

Public utility companies supplying the energy for operating strip mine equipment are faced with the problem of greatly increased demands on their systems. Many times they have been able to handle this increased capacity by switching to higher voltage transmission lines. Mining companies using large quantities of energy can get a more favorable contract if they receive power at the higher voltage. To do this the customer must purchase a transformer substation capable of reducing the voltage to that required for the portable equipment.

TRANSFORMATION—Voltage may be reduced in either a one- or two-step transformation. With one-step transformation, primary mine distribution usually is 2,300 or 4,160, with 6,600 and 7,300 V coming into the picture as a result of heavier demands imposed not only by the increase in machine use but by higher horsepower per machine. In two-step transformation, the "super-primary" voltage usually is 13,000. Permanent transformer stations may employ either single- or three-phase transformers, with a trend toward the latter. A number of strip operations also employ semi-portable stations completely or to supplement permanent stations. Commonly called unit substations, they are based on three-phase transformers. Typical ratings are 1,500, 2,000 and 2,500 kva, with the top usually 5,000. Normally these stations include lightning arresters, circuit breakers, ground-protective equipment and other central and protective facilities.

PRIMARY DISTRIBUTION — Primary distribution systems generally fall into three general classes:

1. Pole-mounted high lines.
2. Cable systems.
3. A combination of pole line and cable line.

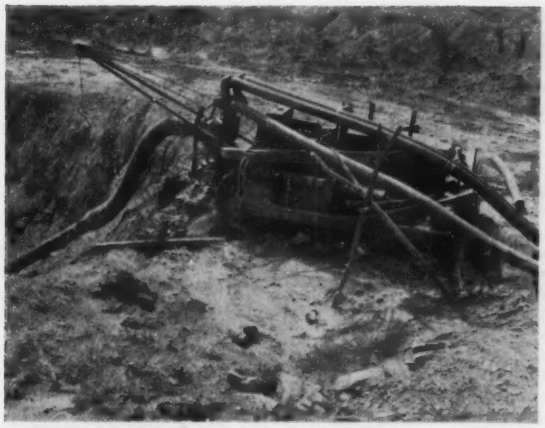
Pole-line practice is largely standardized, with a main line a maximum of 1 mi in advance of the pit and parallel to it. From this main line, pole-line laterals at intervals of 1,200 to 1,500 ft are run to the pit, terminating in switchhouses which supply auxiliary transformers for low-voltage equipment, and also supply the cables on the larger high-voltage equipment. As the pit moves across country, the laterals are shortened at intervals until the pit approaches the main line, which then is moved to restart the cycle. Cables on the equipment usually are 1,000 ft long. Thus, with a lateral spacing of 1,200 to 1,500 ft, equipment can operate freely between laterals with enough cable to spare to permit terminating laterals some distance back when shortening is necessary.

SUBSTATIONS IN PARALLEL — The latest development in strip mine power systems is operation of substations in parallel (*Coal Age*, October, 1956, p 60). At the present time two skid-mounted 1,500/1,725-kva substations are in operation with plans for adding a third unit. The pit power distribution system is entirely by portable cables and multi-conductor plugs and sockets.

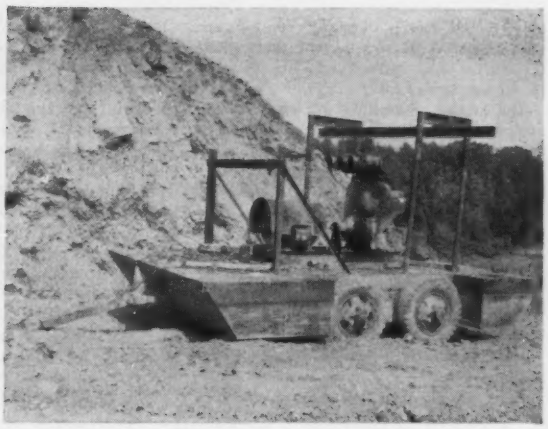
Special mine power cables are used between breaker skids. The cable is similar to the Type SHD portable shovel cable in that it has a copper basket weave over individual conductors. It differs in that it has smaller ground conductors and a thinner outer jacket. This type of cable was bought at a saving of approximately 46%. It is used exclusively on the highwall and seldom, if ever, will it be necessary to move it while it is energized.

The theoretical ideal conditions for paralleling three-phase transformers are:

1. Same phase rotation



SELF-PROPELLED pump is one way of solving the problem of removing water from isolated areas. Unit can cut own road.



AMPHIBIOUS pump carrier, at home on land or water, requires a minimum of attention. Unit carries large 10-in pump.

2. Same phase-angle shift
3. Same polarity
4. Identical turn ratios and voltage ratings
5. Equal per cent impedances
6. Equal ratios of resistance to reactance.

Since the substation units at this mine are identical, the last five items above are automatically taken care of. To parallel two or more substations phase rotation must be the same. Phase rotation refers to the order in which the terminal voltages reach their maximum values. In paralleling, those terminals whose voltage maximum occur simultaneously are in phase and are connected together by the circuit breaker. Each substation unit is equipped with necessary equipment that will not permit the breaker to be closed, paralleling two substations unless the voltages on both sides of the breaker are the same phase. Added safety features are incorporated within the substation design to indicate to the operator of the substation the unit voltage level and load at all times on both sides of the breaker.



SUMP at low point in pit can serve as collecting point for all water. Truck-mounted pump at this installation relays water through aluminum pipe to ditch.

GROUND-CABLE SYSTEMS — A fair number of strip mines use the "ground-cable" system instead of pole lines, or a combination of ground cables and pole lines. Otherwise, the basic plan is the same. A complete system consists of the main cable and the laterals, the cable being fabricated in sections of 1,000 to 1,500 ft as a rule with connectors for termination in switch-houses or for joining the main-cable lengths by junction boxes. Several types of cable may be employed but the most common is Type SHD. Construction includes copper shielding braid over each insulated conductor to equalize surface stresses and eliminate static discharge—the cause of corona cutting. The shielding must be at ground potential at all times, and therefore must be properly grounded, which also eliminates the hazard of shock in handling the cable. Grounding conductors are placed in interstices. It is the safest and most widely used for high-voltage (up to 15,000) portable power applications.

Within limits, distance of transmission of 4,160 volts becomes critical, as a rule, only with the heavy loads encountered in the use of large shovels and draglines rated from 20 to 25 cu yd and up where connected horsepower per unit runs from approximately 2,000 to 5,000. Under such circumstances, the transmission distance for 4,160 volts normally should not exceed 5,000 to 6,000 ft. Above that, at high-voltage—33,000 for example—a pole line is cheaper to construct and also improves regulation and reduces power loss.

With the success of the 60-yd unit and advent of the 70-cu yd shovels, operating voltage moved up to a new high of 7,200 volts. Power is fed directly to the shovel cables from 5,000-kva transformers after passing through automatic circuit breakers.

The 6,900-V cable to the 60-yd shovel has one of the three ground wires insulated and a 110-V potential is maintained between the uninsulated ground wire and the insulated wires. On the shovel there is an annunciator circuit connecting the insulated wire and the equipment frame.

CHOOSING PROTECTION — Primary items involved in the selection of a protective grounding system include:

1. The maximum value of machine frame to ground voltage during a ground fault.
2. The magnitude of fault impedance that can be relayed.
3. Provisions for checking continuity of the ground-wire circuit.
4. Establishing a protective ground separate from the substation ground.
5. Proper choice and rating of components to maintain low frame-ground voltage in event of failure to trip on a ground fault.
6. Immediate isolation of a faulted feeder from the remainder of the system.

FRAME GROUNDING — The frame-to-ground voltage that is developed under fault conditions is approximately the ground current times the impedance of the ground wire. This is the potential to which a man standing on the ground and touching the machine would be subject to when a ground fault occurs.

In a system having a resistor limiting ground fault current of 25 amp where the ground-wire impedance in the cable is 2 ohms, the machine frame-to-ground voltage would be 50. In a system having a 50-amp ground current limit and a 2-ohm impedance in the ground wire, the voltage will be 100.

If more than one substation is used and each has its own ground-current limiting resistor to keep each ground current at 25 amp paralleling them will permit a total of 50 amp to flow in the ground wire in event of a ground fault. The potential drop in the ground wire then would be 100 V. If more than two similar substations, each with its

own ground-current limiting resistor are used the total ground current that would flow in the cable ground would be the sum of all substations.

The grounding resistor will establish the maximum ground current that can flow under solid fault conditions. The tripping current that would isolate a faulted feeder should be considerably less. The ratio of limit value to ground relay pick-up value determines the fault resistance that can exist and still obtain tripping. The higher this ratio the greater the fault resistance can be for relay pickup. It is improbable that a high-resistance will clear, therefore its immediate isolation is advantageous. The ability to relay a high-resistance fault is important in safety grounding systems.

For example, one recommended plan uses a 25-amp ground-current limiting resistor and a ground-detecting transformer and relay combination set to trip at 5 amp ground fault. On a 4,160-V system this resistor value from ground to each phase would be 96 ohms. In a 4,160-V system the line to neutral voltage is 2,400. Thus a total resistance — grounding resistor plus ground wire plus 2,400 divided by 5, or 48 ohms can still obtain 5 amp in the ground circuit. Subtracting the 96 ohms of the resistor from the 480 ohms would permit 384 ohms in the fault. Thus fault resistance between 380 ohms and 0 ohms could be relayed.

Successful functioning of the safety grounding circuit depends on the ground conductors from the machine frame back to the substation being intact. If the ground is broken or an open terminal connection develops, the protection is impaired.

CONTINUITY CHECKS — There are various ways of checking ground-wire continuity. Sometimes a check is made at the start of the shift by imposing an artificial ground fault on the unit and noting tripping of the feeder breaker. The latest method is to provide continuous monitoring of the ground-wire circuit. Sometimes an alarm sounds in the equipment and warns the operator that the ground circuit is not intact. Other methods actually trip the supply breaker. In each of the continuous systems either a pilot wire is required in the cable or one of the grounding wires must be insulated from the other ground wires.

SUBSTATION GROUNDING—To minimize the rise in potential of the protective ground and the frames of mobile machines to which it is connected during the lightning arrestor discharge, or in case of flashover of any of the substation equipment, the substation protective ground resistor should be connected to a separate ground. This ground should have as low a resistance as possible — under 5 ohms — and should be located some distance from the main substation ground.

POWER FACTOR—To prevent power penalties resulting from power factor below that specified in the power contract, synchronous motors, 0.8 leading, are installed on the m-g sets on large excavating units. Without correction, power factor would usually average between 68 to 85%, but with the proper correction will be up to 90 to 95%, which will be above the penalty area.

CABLE TESTING AND FAULT-FINDING—Insulation failures and shorts in high-voltage distribution or service cables in strip pit can cause major delays unless special facilities are provided for locating them. Without such special equipment, about the only method is to apply high voltage and current and blow the cable up at the point of fault.

Equipment for testing and fault location may be made or purchased. A testing outfit that may be made up from purchased components employs, among other items, a half-wave rectifier tube and filament and plate transformers to produce DC at up to 30,000 V and 40 milliamp, or sufficient to test up to 7,500 V. In operation (*Coal Age*, May, 1953, p 108) voltage is applied slowly to one conductor, with other conductors, shield or shields and ground wire or wires grounded. When the cable is fully charged, the current flow is the true leakage current, registered on a milliammeter. The voltage is held for a period and leakage current is determined at intervals to develop a polarization curve. The shape of the curve indicates the electrical condition of the cable and exposes potential insulation weaknesses.

For locating faults, the test equipment is modified by the addition of a spark gap and condenser. Location is achieved by picking up the discharges sent forth by the condenser and spark gap, which are audible at the trouble spot if there is water soaking or there is not a dead short. Where this is the situation, the observer has only to walk the cable. If the fault resistance is very low, dead ground or under water, a pickup coil and earphones are employed and the fault point is marked by a change in the signal. Commercially developed units may be purchased to achieve the same results.

Drainage

Keep pumping to a minimum by preventing inflow to pit wherever possible.

Rely on gravity drainage as much as possible if water accumulates in the pit.

Employ automatic pump controls to reduce labor cost.

Consider the use of check valves in suction lines to eliminate the need for priming.

Study the application of self-propelled pumps for dewatering jobs in isolated areas.

Consider automatic lime-feeding devices for low-cost treatment of acid water in isolated areas.

PREVENTING INFLOW — To keep drainage costs to a minimum, water should be kept from entering the pit and off the haulage roads. Several ways of doing this include: (1) diverting streams to new channels to prevent seepage into the work area; (2) ditching above the highwall to divert surface runoff away from the pit; and (3) building flumes to span the pit.

GRAVITY DRAINAGE — When water does enter the pit, as a result of rainfall or seepage, gravity should be used as much as possible to remove it. By exercising care in spoiling, leaving windows in the spoil areas or putting in crib culverts or drain pipes at intervals, water can be handled economically. If grades favor it, one end of the pit may be kept open to release all the water. In some cases it will pay to blast a ditch in the pit floor so water can flow by gravity to a drainway through the spoil area.

PUMPING — Portable pumps, either mounted on skids or wheels, are the leaders where pumping is required. These are used in a variety of sizes and capacities, depending on the job to be done and are powered either by electric or diesel motors. Many of the units are controlled by float switches that stop or start them automatically.

The hose is popular for temporary water lines but is frequently supplemented by a variety of new materials, including flexible plastic, special rubber and aluminum pipe. Resistance to corrosion, rot and abrasion have made plastic pipe more popular, while ease of handling makes aluminum desirable. Threadless couplings, in addition to the advantage of fast joining and installation of pipelines, also permit individual joints of pipe to be rotated 180 deg if a small leak occurs in the bottom as a result of abrasion. Thus pipe life can be greatly increased. Check valves should be included in all suction lines to eliminate the need for priming pumps. However, this may not be desirable in cold weather when there is danger of the lines freezing. If corrosion and abrasion are problems, impellers and pump interiors can be coated with rubber-base material to increase their life.

NEUTRALIZING WATER—To prevent acid water from entering the water sheds of surrounding streams, one company developed an automatic device that provides low-cost water neutralizing (*Coal Age*, February, 1957, p 101). Six sumps, each with its own pump, are strategically located on the property. Each pump has a separate automatic treating tank. Water is treated automatically with lime solution and delivered to settling areas before it is permitted to enter the water basins.

A steel mixing tank at each pump is partially filled with water and 400 lb of hydrated lime is added. As the lime enters the tank it is thoroughly mixed with the water by a power-driven agitator.

Lifting cups attached to one end of the agitator pick up the solution at one end of the tank and discharge it into an adjustable trough at the top of the tank. The trough leads to a 2-in hose that carries the lime solution to a point adjacent to the pump suction line. As the solution flows into the acid water it is pulled into the suction line of the pump. In the short journey to the pump and in the pump itself the solution is mixed thoroughly with the acid water.

A tank of solution lasts each pump for 2½ to 4 hr, depending on the acidity of the water. The quantity of solution delivered to the sump is controlled by moving the adjustable trough.

An automatic lime-feeding device requiring no power other than the water itself provides low-cost water treatment in isolated areas at a Pennsylvania strip mine (*Coal Age*, March, 1958, p 148). Features of the unit include operation by as little as a 1½-ft fall of the water being treated; functioning on 5 gph or less; light enough to be carried to the site if necessary; automatic proportioning of lime according to volume of water being treated; adjustable lime feed to meet varying acidity; and 2 to 8 hr of operation without refilling.

Modern Coal Preparation

Objectives

Proper size for the particular consumer application.

Maximum Btu content per dollar spent by the customer through elimination of impurities and moisture.

A high degree of uniformity in all characteristics—size, heat content, ash and so on. Uniformity can be even more important than, for example, the last word in ash removal.

Maximum convenience in use by such means as dustproofing, oil or chemical treatment to facilitate unloading and handling in cold weather, and so on.

Conduct of the preparation operation to attain maximum recovery of coal values at lowest possible cost.

Basic Approaches

Determine to the maximum degree possible what the reachable markets require in size of product; ash, sulphur, heat and moisture content; and dustproofing, freezeproofing and other convenience factors.

Study the coal to see how it fits market requirements and how it can be processed—at reasonable cost—to enhance its value to the consumer and thus its market position.

Design plant or additions to reduce operating labor by automatic equipment and controls, and to reduce maintenance by use of modern long-lived materials.

Operate plant to recover the maximum in coal values, including installation of auxiliary recovery units when economically feasible, and to insure that performance standards and market requirements are invariably met.

Practice Trends

Fine sizes constituting larger and larger percentage of shipments, with corresponding reduction in facilities for and output of coarse fraction.

Water-clarification and slurry-recovery installations increasing in number and complexity.

Storage of both raw and prepared coal registering further gains in number of installations and their capacities.

Where to Find It . . .

Raw-Coal Storage ..... p 287
Capacity . . . Underground storage . . . Surface storage

Raw-Coal Blending ..... p 288

Preliminary Breaking ..... p 289

Rough Cleaning ..... p 290

Raw-Coal Sizing ..... p 290

Hand Picking ..... p 291

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Washing practice . . . Medium handling . . . Flotation

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Accuracy factors . . . Screen wear . . . Blinding—cause and elimination

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Rail methods . . . Clean-coal storage . . . Truck loading . . . Barge loading

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Raw-Coal Storage

Consider for these purposes:

1. Preventing interruptions in mine operation from shutting down the preparation plant and vice versa.

2. Providing some degree of blending of the raw feed to the plant.

3. Providing a means of evening out the flow of coal to the preparation facilities, thus permitting washing equipment, for example, to do a better job.

MINIMUM CAPACITY where storage is designed to provide a reserve against production interruptions, rather than merely as a convenience in dumping and transferring coal, normally is at least ½ hr of rated plant capacity. Anything less is not likely to be of benefit in reducing or eliminating the consequences of irregular plant feed or mine or plant breakdown.

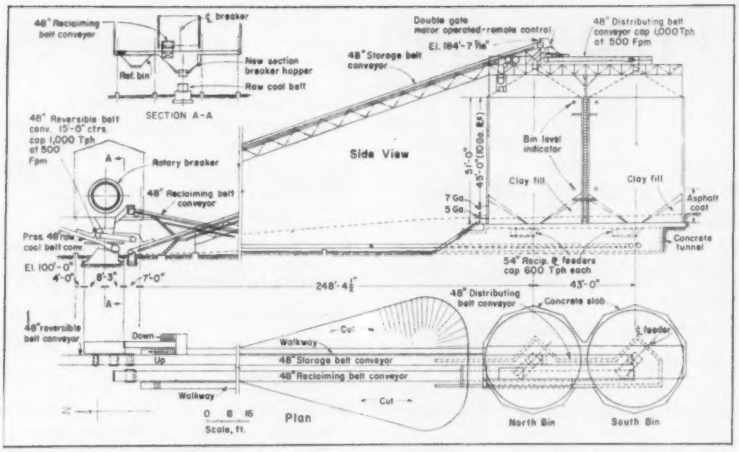
Much-larger storage is an increasing trend, using either single bins, multiple bins or ground facilities. Bin capacities of up to 15,000 tons single are fairly common, as also are ground-storage installations up to 300,000 tons or more.

Underground Storage

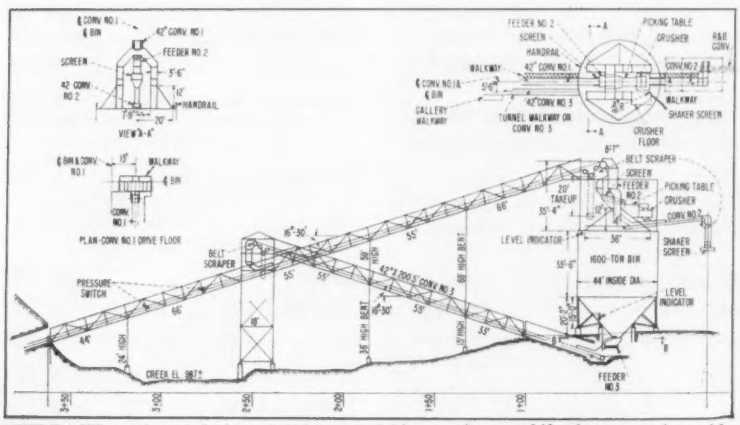
Capacity of one hopper feeding a slope belt at a plant rated at 500 tph is 260 tons. The hopper is 16 ft wide and 66 ft long. Maximum depths is 18½ ft. Designed to receive coal from a belt system this hopper is fitted with a shuttle-type distributing conveyor with hinged boom end. The boom section permits laying coal into the hopper with minimum degradation. The shuttle principle also makes possible maximum use of bin capacity.

The dumping characteristics of drop-bottom cars also permit maximum use of bin capacity and thus can cut down size and depth; for example 96.7 tons in a bin 40x12 ft by 10 ft deep.

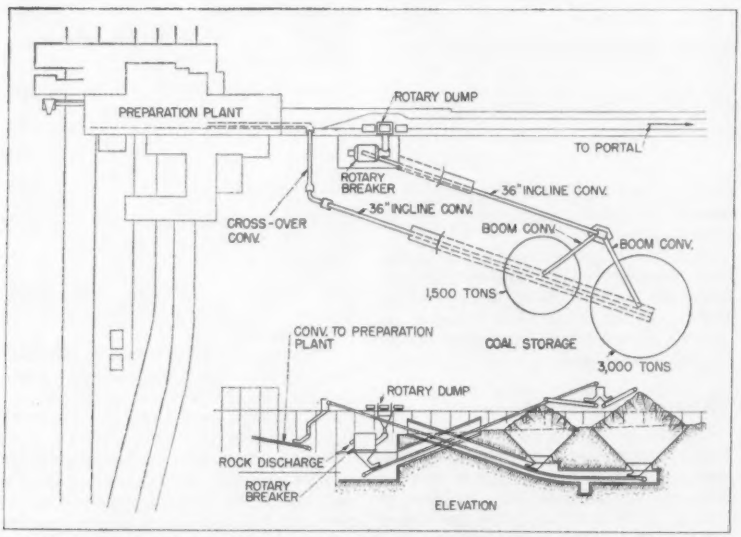
Size of underground hoppers occasionally reaches as much as 2,000 tons. Usually hoppers of this size are employed where there are two seams close enough together so that the hopper can be excavated in the interval to receive coal from dropbottom cars.



TWO STEEL SILOS with clay-filled corners, preceded by a rotary breaker, provide 3,000 tons of storage at a strip operation in addition to 1,000 tons in the dump hopper.



FEEDBACK to slope belt from 1,600-ton steel bin permits one-shift plant operation with two-shift mine-operation.



GROUND STORAGE here involves rough cleaning, distribution to two funnel-shaped pits by boom conveyor, and reclamation by feeders to subway conveyor.

Surface Storage

Although some form of bin or hopper still is the most popular form of surface storage of raw coal there is as previously noted a trend toward open or ground storage.

OPTIONAL-FLOW STORAGE — Optional-flow setups are those where the coal usually goes to the plant but can be diverted into storage, either in bins or hoppers or on the ground. Three accompanying diagrams show (1) feedback to a slope belt from the plant bin, (2) dual steel silos following a truck-dump hopper, and (3) distribution to two ground pits after rough cleaning. Ground pits also may be located over slope belts, or flat storage areas may be served by conveyor-stackers with parallel conveyors, supplemented by dozers or front-end loaders, to return the coal. Truck handling is a common practice also.

IN-LINE STORAGE—In an increasing number of instances the storage facilities are inserted in the line of flow so that the coal must pass through them. In many instances this simplifies the installation and can save in capital and operating costs.

Hoppers are fairly common, with one open-top concrete installation at the head of a slope, equipped with 26 feeders, holding a total of 15,000 tons. Though storage is the main objective some blending is achieved. Smaller silos and other types of storage units, including truck and mine-car dump bins, are other common units.

Conveyor stocking and reclamation is the logical practice with in-line ground storage. The accompanying illustrations show (1) a 12,000-ton facility at a new slope mine, (2) a twin-pile setup (5,000 tons each) in an earthen-dike enclosure with a reversible conveyor for distribution, and (3) a hillside pile (12,000 tons) fed by a radial stacker with a 15-deg movement. A growing practice is to precede such piles by preliminary crushing or breaking facilities.

For a complete discussion of these and other forms of storage, prepared coal as well as raw, see the special *Coal Age* Operating Guide, "Mine Storage of Coal," December, 1959, p 105.

Raw-Coal Blending

Consider to assure maximum uniformity in the characteristics of the coal fed to cleaning units and thus in turn, assuring a better final product by enabling the units to do a better job.

Provide storage capacity and even out the rate of flow to cleaning units, thus helping to promote uniformity and quality in the final product in another way.

BIN FACILITIES—Since the usual goal in blending raw coal is splitting it up into small increments and then recombining it, also in small increments, the normal blending plant consists of a multicompartment bin with a relatively large capacity—usually 1,000 to 2,000 tons or more up to 10,000. The more the compartments, within reasonable limits, the more the opportunity for splitting and recombining. Also, to facilitate putting small portions of coal into each

compartment, the usual practice is to employ a belt with a traveling tripper, though other methods of distributing the coal may be employed. To complete the recombining—and blending—coal normally is withdrawn from all compartments at the same time. Variable-speed feeders are common for this purpose.

Normally, the coal is placed in the blending plant after preliminary cleaning and crushing.

A less-common type of blending is getting the desired mixture of coal from, say, two different seams. This requires a bin or set of bins for each, which may be filled in any of the usual ways, including dumping directly from mine cars or from railroad cars at a central or "milling-in-transit" plant. Blending of two coals also may be accomplished by feeding as desired from side-by-side ground-storage piles to a plant feed conveyor.

PROPORTIONING—Where two or more coals may come via belts from different mines, belt speeds may be controlled automatically to insure that the desired blend is constantly maintained. Weighing devices on each belt transmit signals to motor controls and these in turn adjust the speed of the satellite belt or belts while the final belt receiving coal from the others runs at a fixed rate (*Coal Age*, August, 1958, p 108). Other types of feeders may be similarly equipped if desired.

Primary Breaking

To reduce all oversize material in the raw feed to a certain top size, say 6 in.

To reduce extra-large lumps without especially attempting to get everything to a certain top size. Convenience and smoothing out the flow of coal through the plant are the major objectives. Freeing bone or partings from coal to facilitate picking or cleaning is another in some instances.

PRELIMINARY BREAKING and certain rough cleaning usually go hand in hand, although, for example, if coal is being transferred from a hopper to a crusher preceding a slope belt underground, no attempt is made as a rule to remove rock or impurities before the breaking process. On the surface, however, it is generally accepted that where substantial quantities of rock are encountered it is best to remove at least part of it before sending the product to the crusher. Consequently, particularly where all the coal is to be washed, it is common practice to employ a picking table or—as is increasingly the case—a scalping screen and picking table ahead of the crusher.

Preliminary breaking is almost entirely the province of the roll-type machine although some pick breakers are employed to get closer to the desired objective of reduction with a minimum production of fine sizes. An alternate also providing rough cleaning is the rotary screen-type breaker.

Roll diameter, tooth design, tooth positioning and speed are major factors in holding down fines, along with keeping teeth in good condition at all times. Double-roll crushers are considered to give a higher pro-

Field Reports

Super Preparation Plant—Incorporating four independent coarse- and fine-coal circuits with a total capacity of 1,500 tpd, new super plant features one-man control of 90% of operations. Facilities include tank-type heavy-media vessels and twin-deck tables, plus centrifugal and heat drying, thickeners, vacuum filters, flotation cells and dust collectors. *Coal Age*, July, 1959, p 80.

Entrainment Drying—Employing entrainment principle, new dryer handles 180 to 230 tph of 10M fines, cutting moisture average from 12.4 to 9.5%. After fuel-oil starting dryer operates on dust. *Coal Age*, August, 1959, p 102.

Heavy Medium in Anthracite—New plant employing drum separator uses adjustable crusher to meet fluctuations in size demand. Five sizes are cleaned on single- and double-deck tables. Raw-, rough-cleaned and clean storage insures flexibility in serving truck customers. *Coal Age*, October, 1959, p 114.

Rotary-Kiln Drying—New unit for coal up to 2 in features dust firing, automatic control outdoor operation. *Coal Age*, November, 1959, p 118.

Dual Circuits—Control from three stations with three operators features plant with capacity of 5,000 tons in 5 hr, 15% reject. Equipment includes 15,000-ton open-top bin, jigs, twin-deck tables, centrifuges for 3/16x0 and flash and screen-type dryers for ⅜x0 and 1¼x⅜. Closed circuit achieved with filters and thickener. Automatic samplers provided for raw coal and all prepared sizes under 1¼ in. *Coal Age*, December, 1959, p 92.

Mine Storage of Coal—Equipment and practice in storing raw and prepared coal in bins and hoppers and on the ground. Special Operating Guide, *Coal Age*, December, 1959, p 105.

Reconstruction to Enhance Market Position—Coal-washing tables, froth flotation, centrifugal dryers, cyclones, filters and thickeners upgrade fine-coal quality. Baffled concrete tank cleans up plant effluent. *Coal Age*, January, 1960, p 92.

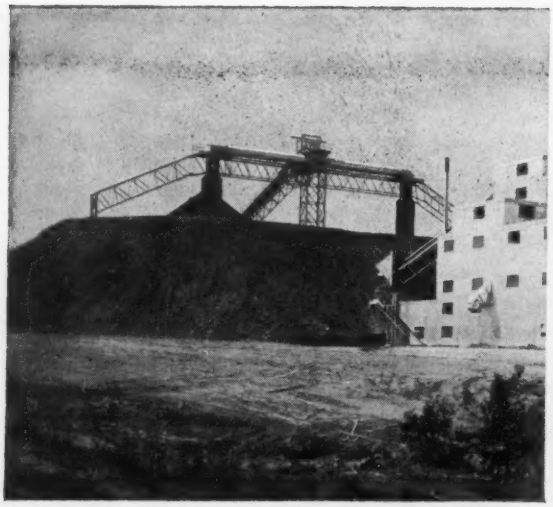
Design for the Future—Presently handling coal from one seam, new plant is designed to meet future needs when second seam is recovered. Facilities include outdoor-type rotary breaker, two-stage jig washing, crushing, centrifugal drying and oil treating. *Coal Age*, February, 1960, p 128.

Coal Screens and Screening—Screen functions, such as, conditioning and sizing, screening equipment and its special and regular uses, screen installation and feeding methods, and screen maintenance, plus Buyers' Guide. Special Operating Guide, *Coal Age*, April, 1960, p 107.

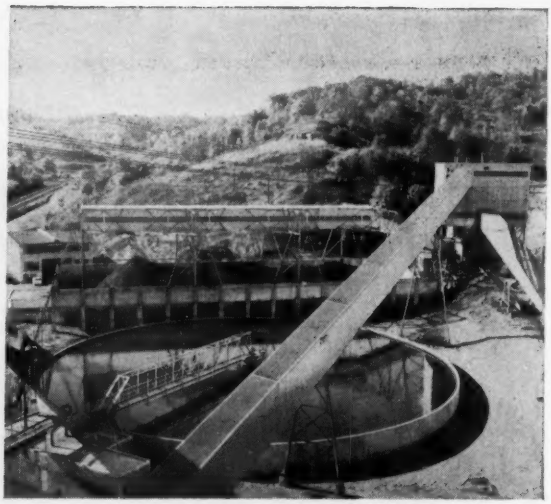
Metallurgical Preparation—Crushing to 5x0, jig washing and thermal drying feature 400-tph plant. Water circuit includes settling cone, centrifuges, cyclones, thickener with flocculation and vacuum filter. *Coal Age*, May, 1960, p 70.

Updating Facilities—How one plant started with air tables, followed up with heavy medium and recently went to modern coarse- and fine-coal facilities, including coal-washing tables, centrifuges, cyclones, filters and fluid-bed dryer. *Coal Age*, June, 1960, p 80.

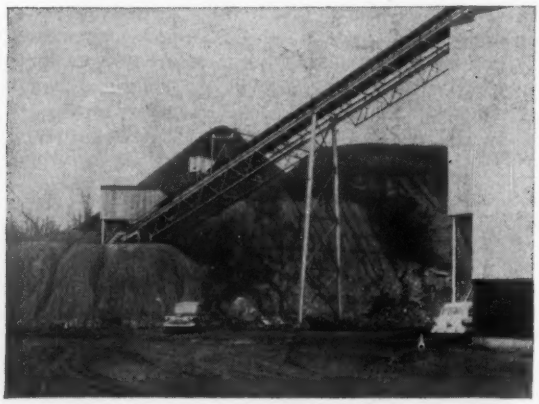
New-Idea Plant—Architectural design blending into community, soundproofing of entire plant, first tubular conveyor galleries, rubber-padded rails to reduce chatter at dump, and pipeline refuse transportation feature new plant with 8,000-ton blending bin, sand cones, coal-washing tables, flotation equipment, desilters, radial screen and centrifuges, plus river receiving and shipping facilities for metallurgical coal. *Coal Age*, June 1960, p 94.



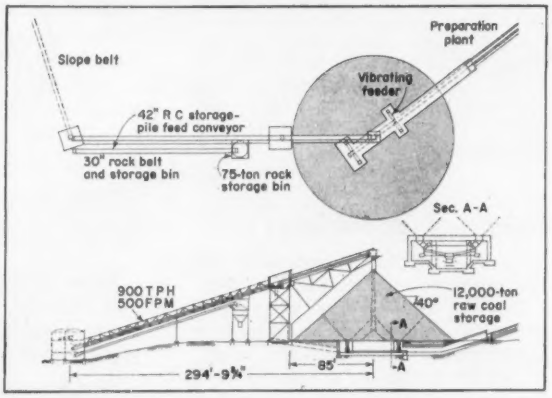
TWIN PILES, one for each of two seams, feature this in-line raw-storage setup with reversible stocking conveyor.



OPEN-TOP HOPPER fed by tripper belt provides capacity of 15,000 tons of raw coal. Multiple feeders permit blending.



HILLSIDE IN-LINE PILE is made by radial stacker with 15-deg movement. Capacity of the pile is 12,000 tons.



IN-LINE RAW-COAL setup for new mine, with motorized telescopic chute, provides for 12,000 tons of storage in coal-flow route.

portion of coarse material because abrasion against the plate is eliminated. Feeding practice also influences results in this direction. Consequently, usual practice is to scalp out fines and send only large material to the crusher.

STAGE CRUSHING—In anthracite, particularly, stage crushing has been the practice for many years because of the nature of the raw product and also the size list produced.

To avoid a multiplicity of units, crushers are offered with a second stage of reduction built into them.

Crushers normally are built to handle iron, particularly if it is not too large. However, the better practice is to keep it out not only of crushers but of the entire plant circuit. If possible, therefore, magnetic removal equipment should be installed in the circuit ahead of raw-coal crushers.

Rough Cleaning

Quick removal of coarse rock and other impurities reduces the burden on subsequent preparation units and also permits higher efficiency in the removal process itself.

THE MAJOR rough-cleaning methods are as follows:

1. **Picking table** receiving all the mine-run product.

2. **Scalping screen** followed by a picking table. This is a preferred system, since it removes the fines and thus facilitates picking.

3. **Rotary screen-type breaker,** which accomplishes both a reduction to a certain top size, depending upon the size of perforation, and rejects the hard rock—or at least that portion of it larger than the perforations. Normally, where rotary breakers are employed final cleaning is done in mechanical equipment.

4. **Conventional screen** to accomplish the same result as that attained with the rotary screen-type breaker. In one instance, a vibrating screen first removes the fines, after which the lower section functions to remove rock which rides over while the softer coal drops through.

5. **Roughing cleaner** to throw out the major part of the heavy material and prepare the feed for the final units. Fines may be bypassed around the roughing unit, while large lump usually is processed by hand picking. Preliminary breaking may also precede roughing with a mechanical cleaner. A further refinement is hand picking to remove coarse, heavy material, followed by breaking and roughing.

Rough cleaning by hand frequently precedes breaking, as noted in the previous section, and has the advantage, among others, of reducing the load on the breaking unit and reducing the output of fine sizes in the breaking operation by getting the hard, heavy rock out of the way.

Separate headhouses or roughing plants are being increasingly employed for preliminary breaking, rough cleaning, mine-rock disposal and raw-coal screening.

Raw-Coal Sizing

PURPOSE: Separation of the feed into the necessary fractions to permit picking,

cleaning and other operations on the various fractions. In plants preparing by hand picking and cleaning, the raw-coal screen may also make the final sizes to be loaded.

THE SHAKER SCREEN, inclined at approximately 15 deg and with a crank or eccentric drive providing a stroke of around 6 in and a speed of 100 to 120 strokes per minute, is the common type of raw-coal sizing device. It is receiving increased competition, however, from vibrating screens, usually of the mechanical type.

A major difference between the two types of screens lies in the fact that the shaking unit also can be employed to convey and distribute the products, including provision for hand picking, as in plants preparing by hand picking and screening.

A second difference between the two types of screens is the fact that the vibrating type, though it cannot do conveying, provides higher capacity in a given space in many instances. Degradation with either depends upon type of coal, type of screen and method of operation.

FLEXIBLE SUSPENSION—The flexible-arm or Parrish-type screen, usually operating at 150 to 185 rpm, 5- or 6-in stroke, 2- to 5-deg slope, is another form of shaker. However, its major use is more for final sizing and dewatering, especially in the anthracite field, where it is widely used for this purpose. Laminated-plastic hangers are now used on such screens instead of boards. Advantages include longer life, no change in length and better screen action.

Carrying the flexible-suspension idea still further, a new shaker employs wire ropes instead of hanger boards or rods. Consequently a minimum of stress is transmitted to the structure. This is made possible with a new-type drive that employs the principle of rotating counterweights and retains the stresses within the drive unit itself while imparting shaking action. The screening units may be single or double. In the latter the opposed units discharge to a common chute at the center.

Screening Factors

In addition to inclination, speed and length of stroke (or amplitude with vibrators), some of the factors affecting screening results are:

1. Depth of bed. Since screening can be accomplished only when the smaller sizes work their way down to the plate, depth of bed, in conjunction with size of opening and square footage of screening surface, is a major factor. With large openings depth of bed may be greater. With smaller openings, bed depth must be reduced or the area of screen surface must be increased. Time on the screen also is a factor, though the opportunities for increasing it are somewhat limited. Where it is increased degradation and breakage tend to increase with it.

2. Degradation. As previously noted, time is a factor in degradation. Narrow shakers also tend to increase degradation, and there is a major increase when more screen surface is provided than is necessary to accomplish the desired separation.

3. Wear. Heavy loads, coarse material and the possible presence of considerable rock are factors in wear on raw-coal screens. Among the answers for vibrating equipment is heavy alloy wire or alloy plate. On shakers, types of plate used to reduce wear include cast manganese.

For a detailed discussion of screen design and operation, see the *Coal Age* Operating Guide, "Coal Screens and Screening," April, 1960, p 107.

Hand Picking

Consider carefully if worth while. If so, select and operate equipment for maximum refuse removal with minimum labor.

FROM THE STANDPOINT of impurity removal, hand picking normally is effective only on coal 3 in or larger in size. Hand picking may also be employed to improve appearance by removing off-standard material.

Where bony by itself or in combination with good coal is fairly high in percentage, some operators use picking as a means of removing this material, which then is crushed and sold as a power-plant fuel.

Under reasonably good conditions, where the impurity content is high, one picker can remove as high as 6 tph. Under average or poor conditions with a lower impurity content, production may drop to 1 to 2 tph.

Picking Equipment

Picking facilities include belt and apron conveyors, shaking tables and, occasionally, chain conveyors, the latter normally being employed only under special conditions and where the impurity problem is a minor one. All conveyor-type units lend themselves to combining the table with the loading boom.

The flat-topped apron conveyor and the shaking table best meet the major goal of removal of impurities without lifting or other handling beyond sliding the material removed to the discharge point. Other types of conveyors normally require skirtboards and thus necessitate lifting each piece to remove it.

The flat table may be a part of the shaking screen or may be separate. When separate, the table normally is sloped at about 5 deg and is operated at 150 to 160 rpm, 4- to 5-in stroke, crank or eccentric drive. Platform tables used in anthracite have a pitch of ½ to ¾ in in 12, with a 2-in stroke, 370 to 400 strokes per minute. The shaking table also lends itself readily to degradation removal by the installation of a screen section at the discharge end.

Some shaking tables have been equipped with partitions or deflection plates to further ease the load on the pickers by making it possible for them to do no more than push impurities out of the main stream to the center or pull them to the side.

Washing

Choose equipment only after thorough study of coal and market requirements to insure desired results with minimum investment in machinery and operating labor.

Operate equipment efficiently, including a close running check on performance.

WHAT ACTUALLY HAPPENS in the separation of coal and impurities is a complex and to some extent unknown physical process. Particle size and shape are involved, as well as the resistance of the medium used to movement of particles through it, and the fact that coal is cleaned as a mass of particles, with consequent interference between free movement of particles within the cleaning medium.

Since the ideal condition for separation of coal and heavier refuse is a still bath of the proper gravity, and since the true or artificial solutions come closer to this condition, the sharpness of separation is increased. This has led to growing use of heavy mediums and solutions—sand and water, magnetite and water, calcium chloride and others.

Other factors which may favor the use of a heavy medium include more-than-normal irregularity in quality and quantity of feed; a need for changing gravity from time to time; and operation at less than 1.45, where baths without upward currents theoretically offer the best conditions for a sharp separation, though capacity per square foot of area may be reduced.

GAGING SEPARATION DIFFICULTY—A good indication of the difficulty of separation is the amount of material in the raw feed that lies close to the gravity of separation. In other words, the greater the percentage of near-gravity material, the more difficult, as a rule, the separation. A good indication of the efficiency of a cleaning operation is the quantity of misplaced material—coal in the reject and reject in the coal. To apply this measure, however, the inherent ability of the cleaner itself to separate coal and refuse must be known, since cleaners vary in their ability to achieve a given separation. Evaluation of this ability is a somewhat complex process, but methods of achieving it include those in "Evaluating Preparation Results," *Caol Age*, April, 1950, p 80.

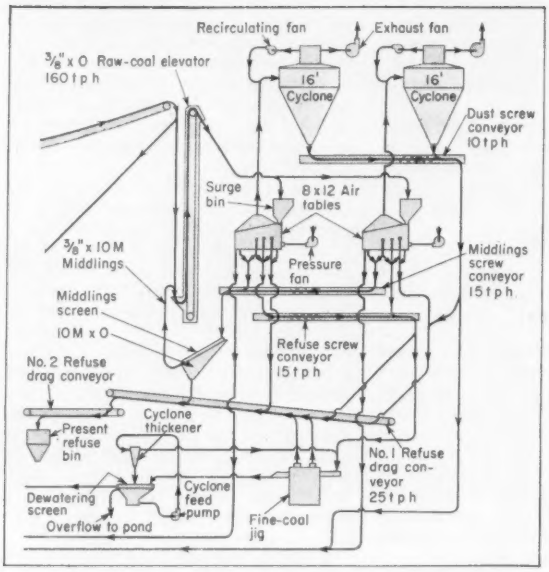
In the main, however, if the washer is properly selected, is kept in adjustment, and is properly operated (see suggestions later in this section) it will provide the requisite separating efficiency. Basic in selection is detailed knowledge of the characteristics of the constituents of the feed.

Where it is evident that the problem may be difficult and the maximum in efficiency is desired, it may pay to wash sizeable tonnages in pilot equipment or actual going plants to check test results. The results of washing a new coal may also be predicted by mathematical or statistical methods, such as that described in "How to Predict Results of Washing a New Coal," *Coal Age*, June, 1952, p 98.

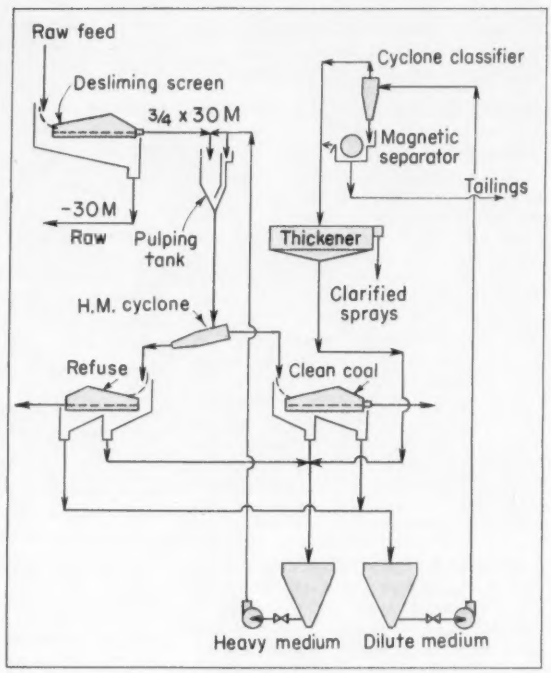
Washing Practice

SIZE SPREAD IN FEED—Certain types of washers require a rather small range in the size of the feed. Examples include the mechanical jig, classifier-type units, and certain washers using heavy media. The emphasis in design in recent years, however, has been toward equipment that will handle a rather large range of sizes—for example, the air-pulsated jig and the usual heavy-media equipment. The latter, incidentally, is now offered for handling a top size of feed ranging to 12 to 14 in.

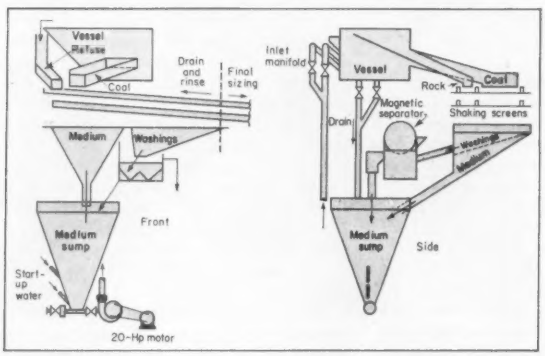
Even where the washer is designed to



RETREATMENT OF MIDDLINGS from air cleaners is the function of the fine-coal jig in this flowsheet for 3/8x0.



CYCLONE CLASSIFIER AND THICKENER in the magnetite circuit feature this plan for a heavy-medium washing cyclone.



SIMPLIFICATION OF THE MAGNETITE CIRCUIT is attained in this design by combining rise-and-drain with final screening.

take, say, all coal from 6 in down to zero, and can frequently do a good job on all the fractions in such a feed, some compromise must be made. Consequently, if tonnage is fairly high and a sharper separation is desired throughout, the practice is to install separate units for the coarse and fine fractions—for example, one for 6x1 or 4x1, and a second for 1x0. Where the equipment requires a closely sized feed, the only out is to install separate units for each fraction it is desired to clean.

BY-PASSING FINES—Fine coal, say ¼ in or less, may be by-passed around washing equipment (1) to keep it out of water and thus avoid the ensuing drying and handling complications, (2) to permit more efficient operation of washing equipment installed to handle a rather wide size range, and (3) because of the problems involved in mixing of fines with medium, such as, sand and magnetite. The fines may be subjected to further treatment in other equipment or, if both their quantity and ash content are not too great, may be mixed back into the washed coal.

UNIFORM FEED—A uniform feed, both in quantity per hour and in impurity content, adds measurably to the efficiency a washing unit can reach. The best method of attaining uniformity in quantity is the installation of some form of surge hopper or bin, plus a mechanical feeder, ahead of the washing unit. Attaining uniformity of impurity content is normally achieved by some form of blending equipment, as discussed previously.

Feeding faults with jigs especially include the following:

1. **Overloading**—More tonnage than the unit can handle.
2. **Unbalanced feed**—More material to one side than to the other.
3. **Segregation**—One side or the other receives the bulk of the fines.
4. **Bad transverse distribution.**
5. **Interruptions**—Stopping and restarting a jig or other washer usually affects results materially.
6. **Fluctuations**—These, plus interruptions, are held by some authorities to warrant very substantial expenditures in raw- and clean-coal storage.
7. **Screen-plate troubles**—Loose plates or screens with holes can break up stratification and result in complete plugging of the cell with coal.

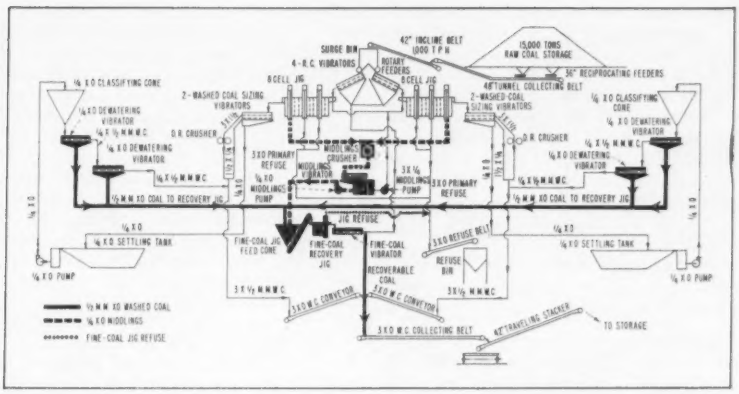
FEED CONDITIONING—Prewetting either in the feed chute or on special prewetting screens facilitates separation when the material reaches the washer.

DESILTING—Another form of conditioning is removing coal fines from the sand used for coal from, say ¼ in down to continuous desilting, which is accomplished in one new installation by flowing the sand and water over a stationary screen and then to a German-developed radial screen. As it flows across the screen it is worked with fresh spray water. The oversize, or silt, flows by gravity to the silt sump, while the undersize, or sand and water mixture, is pumped back to the sand circuit for reuse.

Fine Coal Washing

FINE-COAL UNITS—Equipment now used for coal from, say ¼ in down to around 28M or 48M includes the following:

1. **Continuous upward-current** washers.
2. **Washing tables,** including new double-deck units that double capacity in the same floor space. The importance of proper feed-



FINE-COAL FLOW to new jig includes ½mmx0 from dewatering screens plus ¼x0 middlings. Sizes are blended in feed cone before passing to jig. Two jigs process 25 tph each of coal containing 25% ash.

ing is reflected in the number served by feed distributors.

3. Fine-coal launders.

4. Fine-coal jigs. Such jigs have found rapidly increasing use for both virgin coal and middlings from other types of cleaners. Feldspar is used as the bed in the most-recent of the fine-coal types.

5. The heavy-medium cyclone, which also can handle coarser sizes—up to approximately 1¼ in. The lower limit, in the light of European experience, is about 10 mm. A European cyclone flowsheet is shown in an accompanying illustration. The cyclones are laid almost flat and the pressure is low—in this particular instance, 15 ft of head. Bent-sieve screens are used for desliming and for unloading water and medium, thus materially reducing requirements for rinse-and-drain screens and magnetic separators. An American flowsheet in another illustration also shows the use of a cyclone and thickener in the magnetite-recovery circuit, as well as standard vibrating screens.

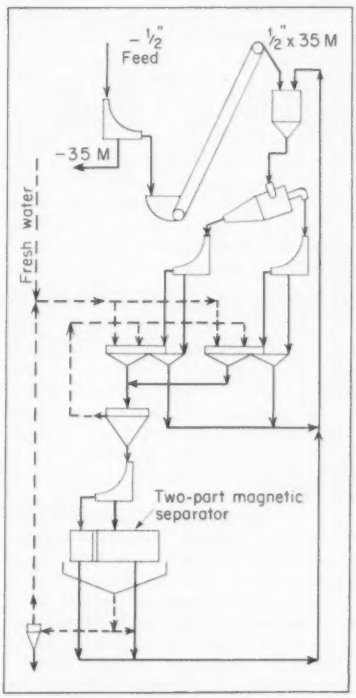
Advantages cited for the cyclone include much less plant space, easy arrangement in multiple units separating at different gravities, no effect on sharpness of separation as a result of variations in load and raw-coal composition.

6. Flotation units, discussed in more detail later in this section.

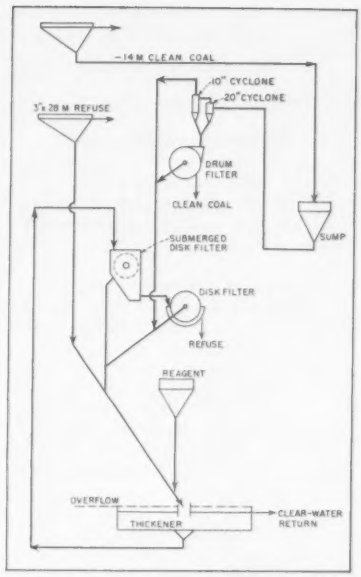
Classifiers and centrifuges might also be considered fine-coal cleaners on occasion. This results from rejection of the extreme-fine fraction which might carry the bulk of the ash.

The big objective in installation of fine-coal cleaning is a profit. This, however, is not necessarily automatic. For example, if 2% of the output was minus 28M but could be beneficated to make it acceptable, the cleaning would be feasible but the coal would wind up in 5 to 7 tons of water, which would have to be removed at a cost of up to $3 per ton of water. Under such conditions, it manifestly would be cheaper to spend the money to mine fresh coal.

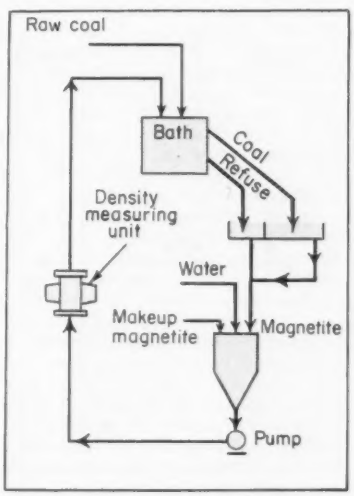
As a modification, if the output of, say, minus ⅛-in was 5 to 6% it might work out that the 1 to 2% of, say, minus 48M, could be discarded because of the extra cost of drying, making possible the recovery and cleaning and drying of the remainder at a profit.



CYCLONE WASHING CIRCUIT for ½x0 features bent-sieve screens for desliming and simplification of magnetite reclamation.



CYCLONE DESLIMING is one feature of this fine-coal setup, which also includes flocculation in the thickener.



DENSITY MEASUREMENT with gamma-ray unit is new method of achieving bath uniformity with magnetite.

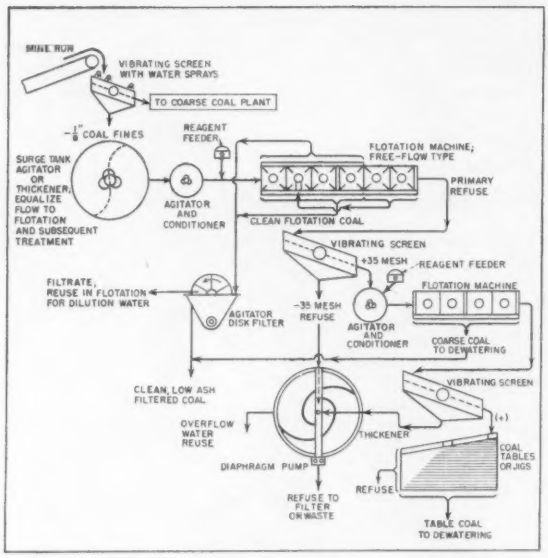
Media Handling

SELF-GENERATION — Though usual practice in the U.S. is to purchase sand or magnetite, medium can be generated in the plant itself. At a British colliery, for example, the medium is a carefully controlled size fraction of the tailings from a froth-flotation plant. These are extracted from minus-60M feed by cyclones, which reject a substantial proportion of the minus-250M material. The facilities supply sufficient medium for six coarse-coal separators with a total capacity of 850 tph.

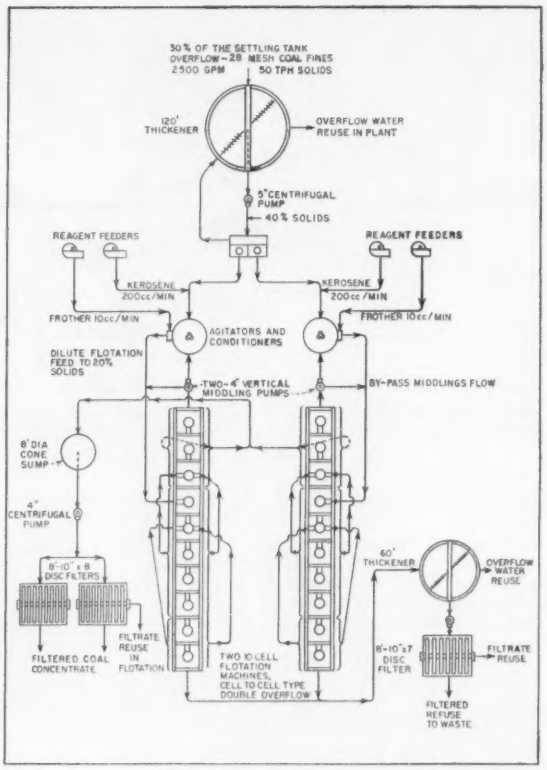
This plant also cleans medium by flotation to prevent coal buildup. Two cells operate on the dilute medium from the rinse-and-drain screens to preserve specific gravity and viscosity of the feed to the separators.

MEDIA CONDITIONING—Reclamation and treatment of the media used in heavy-media systems is necessary for at least two reasons: recovery of an expensive material that otherwise would be lost, and preservation of the proper gravity of the bath in the cleaning unit.

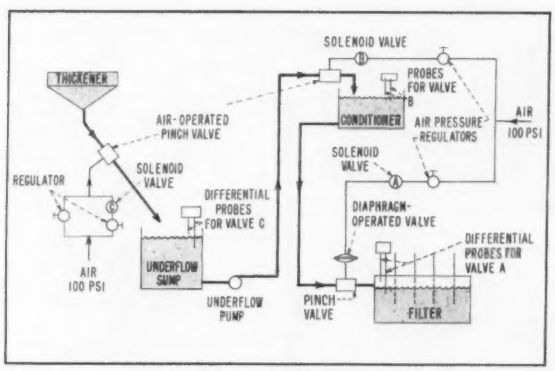
With magnetite, the simplest system consists of a magnetic separator to reclaim the material, previously magnetized to permit



COAL UP TO ⅛ IN is treated in this flotation setup using machines designed for the service. Clean coal, refuse are filtered and thickened, and provision is made for final tabling or jigging of tailings.



FLOTATION SETUP for minus 28M coal using parallel flotation machines with middlings retreatment and following up by filtering both clean coal and also refuse fraction before final discharge to the bank.



AUTOMATIC FEED-FLOW CONTROL for filters employs a combination of probes and valves to achieve uniformity in results.

this to be done, from the water from the rinse and drain screens. This recovered material then is demagnetized and sent on to a thickener or densifier, from which it is returned to the separator bath.

Variations include use of thickener with overflow back to the rinse and drain screens for part of the water, and underflow to a magnetic separator discharging reclaimed medium to a densifier. Tailings go to a second magnetic separator, also receiving part of the rinse and drain water, with reclaimed magnetite to the densifier and tailings to waste.

Each of several heavy-medium separators in another plant is provided with two magnetic separators which return a concentrate of 2.2 sp gr and about 95% magnetic content directly to the medium circuit without further treatment. Tailings from all separators flow to a desliming sump. The underflow from the sump goes to two 12-in cyclones. Cyclone overflow is used as rinse water, while the underflow is reprocessed.

A circuit for a heavy medium cyclone (see illustration) involves returning dense medium directly to the cleaner and using a cyclone, magnetic separator and thickener to concentrate and regenerate the dilute fraction.

DENSITY CONTROL—Automatic control of bath density is provided for in equipment employed with certain new heavy-media cleaning units. At one installation (*Coal Age*, October, 1955, p 63), rinsing is done only on the lower sections of the drain and rinse screens, thus yielding heavy and dilute medium solutions, the former going to the recirculating sump and the latter to a magnetic separator delivering reclaimed medium to the same sump. Adjustment of the density of the medium is performed by automatically adding water as required to the medium returned to the recirculating sump.

At another plant employing the dip-tube principle (*Coal Age*, May, 1956, p 69) the reclamation circuit involves magnetic separator, cyclones and a thickener immediately above the coal-cleaning equipment. Automatic valves release medium from the thickener as necessary to keep the gravity of the bath at the desired figure.

Gamma-ray equipment for gaging density of the magnetite solution as it flows also may be used for automatic control, as shown in an accompanying diagram. The unit actuates high- and low-limit control switches and in turn magnetic feeders and valves to keep density within the desired limits.

CIRCUIT SIMPLIFICATION—Keeping the medium-recovery circuit as simple as possible to minimize capital investment has been the subject of considerable investigation. One plant, using sintering-machine flue dust, which eliminates grinding and recycling at the sintering plant, has simplified the recovery circuit by converting the thickener to a sump; eliminating the magnetizing and demagnetizing coils with no apparent change in the operation of the cleaners; using one drum-type separator per vessel, the product of which is high enough in concentration for delivery to the medium sump without the need of a densifier; and using

the separator tailings as spray water on the feed prewetting screens.

One heavy-medium unit is followed by an unloading screen dropping water and magnetite into a sump directly underneath from which the medium is recirculated. Density of the bath is adjusted by adding thickened magnetite produced by a separator and derived from the coal and refuse rinsing operations.

In another design (*Coal Age*, July, 1958, p 81) the rinse-and-drain screen is incorporated in the final sizing shaker, as shown in the accompanying diagrams. Thus, all screening on the product side is accomplished with a single drive, and only one pump is employed in the medium circuit.

Bent-sieve screens, as shown in the cyclone-washing flowsheet previously discussed, are employed to unload water and medium in at least one plant abroad, materially reducing the investment in rinse-and-drain screens and magnetic separators.

Froth Flotation

As coal and refuse particles get smaller and smaller, their ability to move as desired through water or other washing medium becomes less and less until a point is reached where separation cannot be accomplished on the usual basis. The practical line of demarcation is somewhat indefinite, although the minimum so far suggested for heavy media, for example, is 1 mm, with ½ mm as a possibility. At that point, somewhere around 10M or less, a different principle of separation must be employed to get maximum efficiency with reasonable capacity.

Flotation achieves these goals. Facilities involved in flotation normally include a thickener or hydraulic classifier to size the feed, remove oversize, and so on; reagent feeders and conditioners where the reagent and the coal pulp are mixed and "conditioned"; and the flotation units themselves. The flowsheet also may be modified to include, for example, roughing cells preceding the final treating cells, retreatment units for a coal or primary tailing product from the primary bank of cells, or other modifications.

Two flowsheets showing, in one instance, the conventional setup for minus 28M coal, and in the other matte-type equipment for minus ⅛, are reproduced in the accompanying illustrations (*Deco Trefoil*). In the 28M installation, retreatment is achieved by returning the discharge of certain cells to cells earlier in the series.

The minus ⅛ installation is an example of a relatively simple flowsheet which accomplishes efficient recovery at a low ash content. The coarser fraction facilitates subsequent dewatering. Primary refuse is screened at 35M, and the plus 35 is retreated in a secondary flotation unit, followed by screening of the tailings and final treatment on a table. All the refuse is collected in a thickener for water reclamation. The underflow may be filtered if required or desired.

Desliming, Desilting

Since leaving the extremely small sizes in the raw feed frequently reduces efficiency in cleaning the fine sizes of coal in addition to adversely affecting drying the trend today is to deslime or desilt prior to cleaning or drying. Desliming or desilting equipment includes cyclones, hydraulic classifiers, hydroseparators, bowl-type desilters and radial screens (*Coal Age*, February, 1959, p 112) as well as conventional screens and other equipment. A fuller discussion of desliming appears in the "Dewatering and Drying" section later in this feature.

Air Cleaning

Consider where nature of coal is adaptable to the process to avoid, among other problems, drying.

THE BASIS of cleaning with air is substantially the same as for cleaning with water or other mediums (see preceding section). Air, however, eliminates or reduces the drying problem, although it involves a dust-handling problem similar to the water-handling and clarification problem involved in wet washing.

High-ash and high-sulphur impurities are removed completely but there is practically no bone separation with air as the medium. The lower limit of cleaning with the most-used type of unit today is about 48M. There is no improvement in ash below this size but at the same time all the finer coal is available for mixing with the clean coal, meaning 100% recovery without the sludge and dewatering problems accompanying wet washing.

Air cleaners normally operate on a fairly closely sized feed and, as with water, the feed should be uniform in quantity and as nearly uniform in impurity content as possible. Moisture variations are particularly troublesome in air-cleaner operation.

PREDRYING—Present practice in eliminating the effects of high moisture and lack of uniformity in table feed is to predry and a number of plants recently built include predrying equipment of the heat type.

To simplify the installation and eliminate duplication of equipment to supply air for drying and also for cleaning, one installation employs the drying air for cleaning as well. In this installation, a heat exchanger is employed to avoid passing the products of combustion through the cloth dust separator.

The majority of the air cleaners installed today operate on coal ½ in or less in size, though larger coal is treated. From the standpoint of the drying problem, washed coal over about ¼ or ½ in may be dewatered sufficiently for acceptance without special equipment—at least in many instances—which is in part the reasoning leading to the installation of combination wet and dry plants. And if mine conditions or mining practice make drying of fines desirable, it may be accomplished to the advantage of the air-cleaning process by predrying as previously noted. Normally, 2 to 2½% surface moisture in ⅜- or ¼-in coal is about ideal.

Most air cleaners now installed are three-product machines, and thus normally provide a middlings product for retreatment. The goal in this middlings production and retreatment is maximum efficiency in separation with minimum loss of coal values. Dedusting to remove up to 50% or more of the fines—usually 48M—adds significantly to normal air-cleaning efficiency.

Dust Collection

Equipment for dust collection includes the following:

1. Large expansion chambers into which the dust-laden air is routed to permit settlement. However, such chambers can trap only the larger particles. Smaller baffled units are employed, however, for scalping ahead of other equipment such as cloth collectors.

2. Cyclone collectors. These centrifugal units are a popular means of removing dust from air. Since single units handling large volumes are less efficient because of reduced air velocity, multiple and tandem units are offered, raising separation from, say, 85 to 95%, up to 98%.

3. Turbo-centrifugal collectors. Turbo-type units, usually termed "clones," offer the advantage of smaller size as a general rule. Like the standard cyclones, they are relatively inexpensive to buy, are easy to operate and are low-maintenance units.

FINE DUST—Even at 98% separating efficiency, the quantity of very fine dust that can still escape to the atmosphere can run up to several tons per day. To trap the most of the remaining fine dust, cloth or bag-type and wet-type collectors are employed.

Cloth collectors. Of the cloth-type collectors, the bag type was one of the first to be installed at coal-cleaning plants, normally with a shaking device to remove the accumulated dust. A more recent development is the cloth-screen collector, which provides larger capacity per unit of space occupied, is easier to inspect and maintain, and is provided with an improved cloth-shaking device. To prevent interruptions while the dust is being shaken off the units, dual-unit, or continuous cloth collectors may be installed, the air being directed alternately from one to the other.

Exhaust operation of dry-type equipment keeps the dust within the ducts and equipment in case there are leaks. Acid, abrasion and the like are factors to be considered.

Wet collectors. Wet-type collectors include the tumbler; a combination of turbo-centrifugal unit and water sprays; and the hydrostatic. All have the advantage of high capacity in relatively small space, in addition to a high separating efficiency as a result of the use of water, particularly in the tumbler and hydrostatic units, where the dust-laden air is passed through a water bath. Both units have no moving parts.

A new unit in the form of a cylinder comprises a wet-impingement screen, turning vanes, chamber in the walls to receive the air and water particles thrown out by centrifugal force, straightening vanes and an exhaust fan. One-tenth to one-twentieth the size with high efficiency is among the claimed advantages.

Retreatment

Employ to salvage as much of the coal values as possible, and also to increase the efficiency of the primary separation process.

STEPS in the retreatment of coarse coal are as follows, starting with a product from the

primary washer draw or a special middlings draw:

1. **Preliminary screening** of the product at 2 in or other limit.

2. **Crushing of the oversize** to the screening limit to release the impurities.

3. **Recirculation of the crushed product** to the washer or to a separate retreatment unit. Separate retreatment units are employed where several units handle primary cleaning or where, even after crushing, the recirculated product contains considerable material close to the washing gravity.

With the smaller sizes, particularly less than, say about ¼ in, where crushing is often less effective as a means of releasing the coal values, the entire draw product may be recirculated or retreated in a separate unit. This is particularly true in aircleaning coal under approximately ½ in.

The value of this method of enhancing cleaning efficiency and reducing coal loss is evidenced by the increasing use of separators designed to produce three products: clean coal, middlings and refuse. This has been particularly evident in cleaners of the heavy-medium type.

Salvage

Include in preparation planning to:

1. Reclaim coal that otherwise would be lost because it never gets to the preparation plant, or because the preparation system is set up to reject it without an opportunity to get it back.

2. Recover coal from primary washer rejects left in because of a desire to get sharper separation or because of washer overloading resulting from a change in coal and refuse character or the need for more tonnage.

EXAMPLES of salvage operations include the following:

1. **Crushing and washing of pickings,** either in regular or special units to save coal values.

2. **Picking out, crushing and loading separately** for steam coal a bony product that might otherwise go to refuse.

3. **Processing of roof brushings, track cleanings** and the like to recover a regular or a steam-coal product. Normally, the production of such material should be sizable to warrant separate facilities.

Recovery from primary washer reject also, as a rule, involves preliminary screening to take out fines and crushing to release interbedded material, although the reject may be treated as it comes from the primary units. The latter, however, usually is less efficient and does not give as good a recovery.

Another form of salvage widely practiced in anthracite and to a limited extent in bituminous, is reworking contents of old refuse banks and silt ponds or dumps.

Salvage operations ordinarily are carried on with conventional screening, crushing and cleaning equipment. Exceptions include the use of rock-type screens and crushers, and extra-large draws on cleaners where mine material or pickings containing large percentages of rock are processed. One highly desirable characteristic of a salvage cleaner is ability to handle a wide range of feed in refuse content and quantity.

Clean-Coal Sizing

Whatever the type of screen employed, provide ample capacity, emphasize accuracy, and employ equipment, materials and methods that will keep maintenance to a minimum.

CLEAN-COAL SIZING or classification, is handled by both shaker and vibrating equipment, the latter having made substantial gains in this field as well as in the field of raw-coal sizing.

For a complete and detailed discussion of equipment and methods, see the *Coal Age* Operating Guide, "Coal Screens and Screening," December, 1959, p 105.

Accuracy

Aside from moisture and blinding, accuracy involves time the coal is on the screen surface, and also cloth or plate wear. Time on the screen brings in the question of breakage, or degradation, which increases with increased screening time, though as in anthracite, the hardness of the coal may permit a longer retention time without increase in breakage.

Other things being equal, sufficient time must be provided to permit the smaller sizes to work down and be separated out, and in turn this brings in the question of bed thickness. It should not be excessive if good screening is desired, and the smaller the opening the less the bed thickness should be if excessive length of screen is to be avoided. Where one of the products is screenings and the feed to the unit includes all sizes up to lump, depth of bed should not be more than 4 to 6 in, and screening efficiency and capacity may be increased by placing a large-hole relief screen on the slack section.

In getting fines of coarser material and in facilitating separation in the lower ranges, wet screening is frequently employed. "Washing" in "pools" at intervals along the screen and fitted with sprays is a growing practice, along with dams, special stepped screen sections to turn material over, and so on.

SCREENING EASE—The relative ease or difficulty of screening a certain feed at a certain size, which in turn is one measure of the screen area necessary for accurate separation, reflects in the main the quantity of near-opening material in the feed. If there is a substantial percentage of material at or slightly larger than the opening size, particles smaller than opening size find it more difficult to work down through the bed of near-opening material, and also there is a greater chance that particles only slightly undersize will be carried beyond the screening surface before they have an opportunity to go through. The difficulty increases as the size at which screening takes place decreases.

Screen Wear

Plate, cloth and wire wear reflect load, screening time, abrasive nature of the material, corrosion if the water is acid, and the material used in the screen. Where plain-steel plate is employed, increasing the thickness is one way of offsetting the effects of wear but brings a significant decrease in screening efficiency. Consequently, operators turn to bronze and alloy steels, with stainless coming rapidly to the front in recent years for the smaller sizes. However, as a general rule, stainless life must be 10 times plain steel life to justify its use for wear resistance alone, and therefore bronze or other alloys are favored for heavy plate. With round-rod or wire screens, or with special-profile bars, wear is largely on the top and consequently the period of reasonable accuracy is materially lengthened.

Rubber screens and rubber-clad perforated plate are among the new types created to combat wear.

Small-opening punched plate must be relatively thin, both to facilitate the punching operation and because excessive thickness, as previously noted, affects screening efficiency. Consequently, additional support is required to prevent sag and wear. Bars under the plates are the preferred method. An alternative is the Perister-tread screen—a stepped-type unit in which the risers provide the extra support while the screening is done on the treads. Bars or other supports also are installed under the cloth on vibrating screens.

SPECIAL SCREEN OPENINGS—Elongated openings frequently are employed instead of round or square. Among the goals are: (1) increased screen capacity, (2) reduced blinding and (3) less breakage with friable coals. However, replacing conventional screens with long-opening units, with no change in the effective width of opening, normally increases the size of the through product.

A special form of screen is the lip type, usually with a greater width at the lower end of each opening. It provides a tumbling effect and this together with the type of opening, normally results in an increase in capacity of up to double or more. At some plants this characteristic has resulted in installation of lip screens to offset a condition of chronic overload. Incidentally, overloading severely affects screening efficiency. For maximum accuracy, feeders or other devices should be provided to insure uniformity in rate of feed to screens.

Use of elongated, lip and similar screens brings in the factor of separation by shape as well as by size. Consequently, the products are quite different in character, with considerably more flats in the underproduct with the elongated-opening units.

Blinding—Cause, Elimination

Blinding in coal screening occurs with all sizes but is particularly annoying and most affects efficiency with the smaller material. Blinding reflects in the main the percentage of particles near the size of the screen opening and especially, as the size of the coal decreases, surface moisture.

Additional factors tending to increase blinding include overloading and the presence of clay and shale mud. As a rough rule, a surface moisture of 6% will result in complete or nearly complete blinding at separations of ¼ in or smaller. At 2% or less, little or no blinding occurs.

Aside from blinding, moisture also tends to increase the inaccuracy of screening by causing small particles to stick to larger pieces. Where washing is done, one of the functions of sprays on classifying screens, in

addition to opening up and agitating the bed to facilitate separation, is washing the fines off the large pieces and through the screen. "Pool washing," as previously noted, is one means of facilitating this operation.

The building up of a film of moisture and packed fine material is held to be the major cause of blinding in fine-coal screening. Time is a second major factor. Rust and corrosion with plain steel also especially after the screen has been idle can cause major blinding difficulties, for a time.

Electrical heating is rapidly growing as a means of preventing blinding of screen cloth. Other methods applying to cloth, plate or both, include:

1. Alloy metals which resist wetting and film buildup.

Dewatering, Drying

Tailor the installation to requirements, including prevention of stream pollution, with due regard to keeping the installation as simple as possible by full use of stationary and operating screens, settling, etc.

BECAUSE THE SURFACE AREA on which moisture can collect increases rapidly with reduction in size, dewatering presents a greater problem with fines. As a rough rule, natural drainage will reduce the moisture on coal above ½ in and perhaps down to ¼ in to a point where there will be little or no freezing except in very severe climates. However, it may be desirable to reduce the moisture still further for the reasons set out at the start of this section. Below ½ or ¼ in, in the absence of some other form of treatment, freeze prevention requires specific dewatering methods and equipment.

Examples of the more-comprehensive systems being employed today to dry and at the same time clean up and re-use the water, except for emergency bleed, are shown in three accompanying diagrams. One involves drag tanks, centrifuges, filters, thickeners, flotation and heat dryers. The second also employs much the same equipment with a settling cone in place of drag tanks. It also features a cylindrical-tower-type wet scrubber to clean up the exhaust from the dryer cyclones. In the third, again employing the same general classes of equipment with the exception of thermal dryers, bowl-type desilters are employed in the circuit instead of tanks or cones.

Natural Drainage

Equipment employed in dewatering by natural drainage includes hoppers and bins; inclined and horizontal conveyors with screens in the bottom; perforated bucket elevators; and fixed screens. Fixed screens in flumes from washers to classifying screens, in fact, are widely used for unloading a large part of the water.

The fixed-screen principle for unloading or reducing excess water has been developed into special types of units both here and abroad, including the launder or riffle screen developed for anthracite (*Coal Age*, December, 1959, p 119).

"Radial" and "bent-sieve" stationary screens developed abroad are finding increasing use in the U.S. for various applications. The radial type is employed, for example, in removing silt from sand used in cleaning. It also can be used for screening and for dewatering prior to other drying.

The "bent-sieve" unit is employed for desliming and dewatering either by itself or in conjunction with other equipment. Both types of applications are shown in the cyclone-washing flowsheet in the preceding "Washing" section. Advantages of these stationary screens, and others doing similar jobs, are high productivity per foot of floor and screen space, low or no power requirements, and a substantial reduction in investment for final screening and dewatering facilities.

For coal larger than ¼ or ½ in, dewatering by natural drainage is quick and complete, and the product, as noted, normally will not freeze unless the cold is severe and lasting. Where the finer sizes are involved and freezing is a consideration, the problem becomes more difficult. However, natural drainage of coal as fine as 1/16 in and 28M to surface moistures of 10 to 12% is being achieved with flotation coal.

Mechanical Dewatering

Omitting such processes as thickening and the like (see later section), mechanical dewatering is done by screens, centrifuges and various forms of filters. With all these units, the dewatering process, as with fixed screens, normally involves producing a through product which must be loaded wet, discarded or treated by other means. Also, the overproduct, depending on size, and other factors, may be further processed in other types of equipment.

SHAKER SCREENS — Conventional shakers of course accomplish dewatering, but when dewatering is the specific goal the tendency is to go to special screens, usually flexible-board-hung or supported and operated at speeds of 150 to 400 rpm, with short throws of around 1 in. Anthracite shakers for both dewatering and sizing tend to operate at nearly conventional speed and stroke but with only a slight inclination, usually ¾ in per foot. For dewatering only, the speed is increased to 200 to 400 rpm and the throw is cut to 1 to 1½ in, especially for the smaller buckwheats.

Plate or cloth may be used in dewatering the larger sizes, and plate also is employed for a substantial portion of the smaller sizes in anthracite. In bituminous, however, when dewatering at, say, 28M, the tendency is to use cloth, rod or wedge wire.

When used for dewatering, the shaker-type screen normally will reduce the surface moisture of sizes above approximately ¼ or ⅜ to 5% or less. When dewatering smaller sizes at, say, ½ mm or 28M, surface moistures of as low as 3% have been obtained, but the range usually is 5 to 10% and higher.

VIBRATING SCREENS—When used within their limitations, vibrating screens provide real advantages in the field of dewatering. Initial, operating and maintenance costs are low, and a high removal of solids from wash water is achieved with a minimum of effort. Since operation in a nearly horizontal position is necessary, it usually is desirable to have a high operating speed and a stroke at an acute angle with the screen deck to facilitate the conveying action, which normally is slightly uphill.

Width and length of screen should be selected for proper handling of the expected quantities of water and solids. Openings as narrow as ⅛ mm can be employed in some instances but the usual lower limit is ¼ mm. Special attention to keeping the width narrow enough to maintain a bed at all times is required. Dams in the center and at the discharge end help both in maintaining a bed and in promoting water removal through longer retention of the coal on the screen. However, dams should not be high enough to result in excessive bed thickness.

The bulk of the water should be removed on the first half of the screen for best results, and a bed of the requisite thickness should be formed as soon as possible to prevent excessive loss of the fine sizes. Unloading of as much water as possible before the coal is placed on the screen helps, and if fine sizes from some other unit are added they should be placed gently on top of the bed after it is formed. Size distribution of the primary feed should be such that it will form a bed.

Dewatering results reflect size of coal handled. Where the average size of the feed is around 5/16 in, a surface moisture of 5% normally can be attained, and in many instances much less. Final moisture increases with reduction in size up to 25% or more with, say, 28 or 48M material.

CENTRIFUGAL DRIERS — Equipment of the centrifugal type commonly used in coal preparation includes the following:

1. Vertical units with transporting facilities. Positive transport results in equal centrifugal action regardless of size consist and prescreening is not necessary. Feeds of up to 20 to 45% surface moisture can be handled. If the percentage of extreme fines is not unduly high the unit will cut moisture in a ⅜ or ¼x0 feed to as low as 5 to 6%, with over 98% recovery.

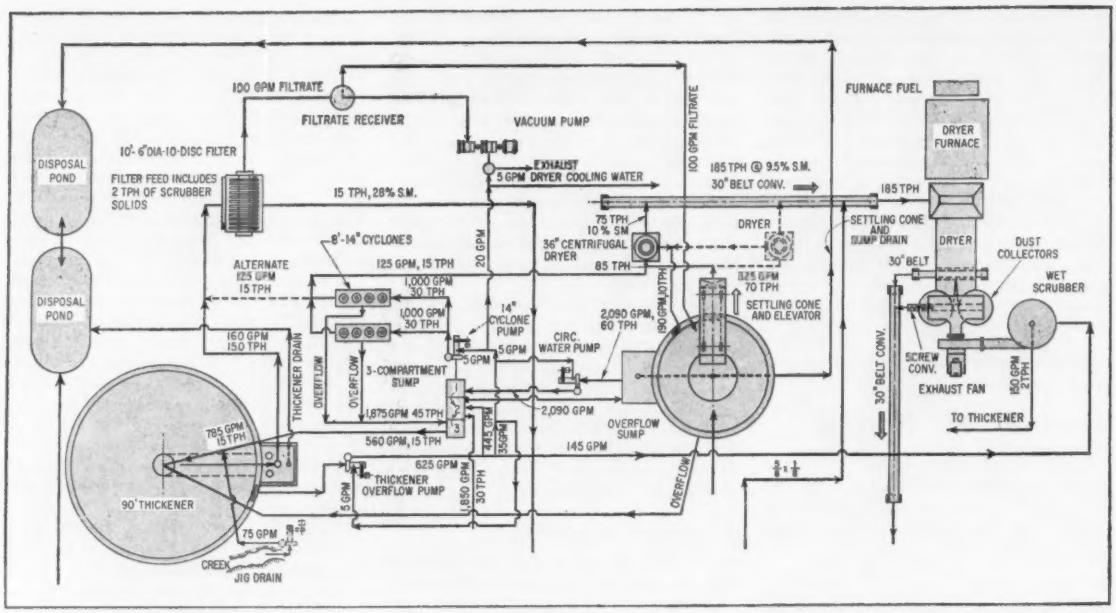
2. Vertical units without transporting facilities, using water or vertical vibration to move the coal. As a result of absence of a basket, minimum screen-plate thickness is about 3/32 in, limiting perforations to about this size. Coal under around 28M usually should be removed from the feed. On ⅜ or ¼x28M, moistures of 5 to 6% can be attained with recoveries of over 75 to 80% as a rule.

3. Horizontal solid-bowl type—simplest of the three but less flexible. Recovery of ⅜ or ¼x0 is 95% or better. Final moistures are somewhat higher than with other types in many instances, though comparable results have been achieved with desliming. An accompanying flowsheet shows one method of employing this unit, as well as vertical equipment plus cyclones, thickeners and vacuum filters in a circuit for ⅜x0.

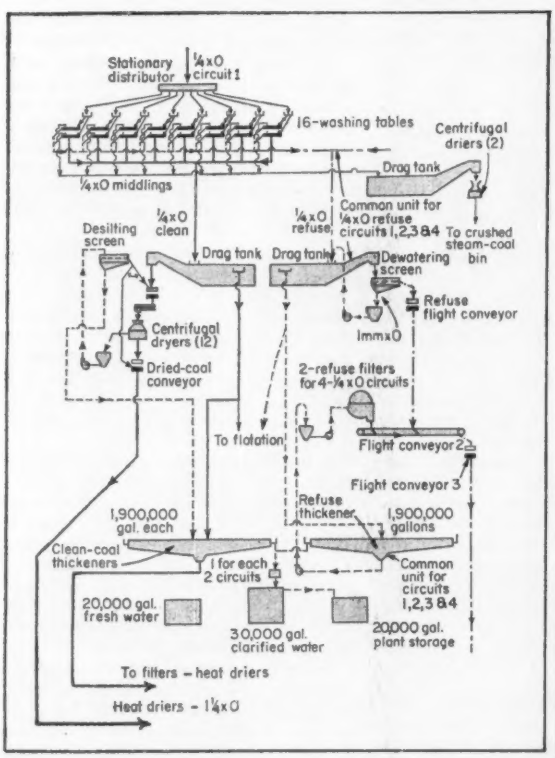
In terms of actual water removed the centrifuge ranks high as a low-cost device, providing a total cost of between 5 and 10c per ton of cake. Degradation in operation must be expected with some types and under some conditions. Means of reducing it include:

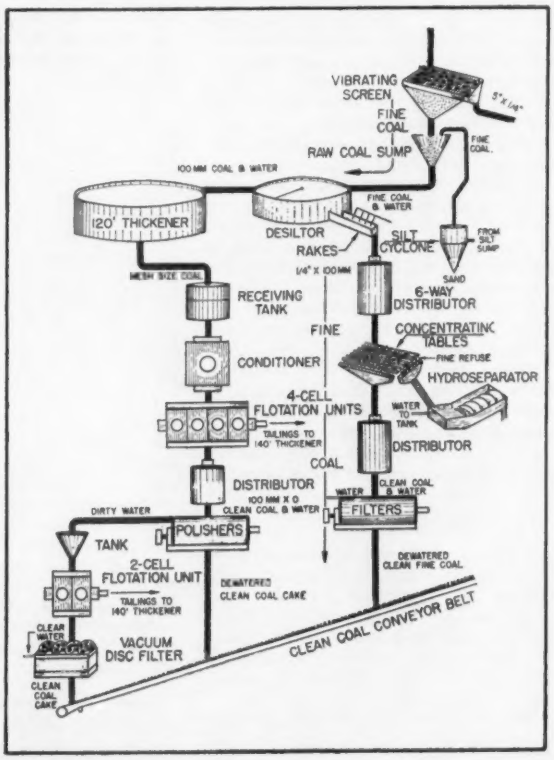
1. Introducing the coal evenly around the top of the basket at approximately surface speed, in turn a function of the number of vanes in the receiving element of the centrifuge.

2. Clearance no greater than particle size



COMPREHENSIVE SYSTEMS for coal drying and water handling as exemplified by three recent installations involving most of the equipment employed in modern plants of today for maximum recovery and comformity with pollution regulations.





in the machines with transporting facilities.

3. Use of rubber skirts instead of metal or concrete wear rings at the bottom to reduce discharge impact.

FACTORS AFFECTING CENTRIFUGAL RESULTS—The size of the fines fraction affects the results of centrifuging in much the same way as it affects the results of other forms of drying. As an example, solid-bowl units have produced surface moistures of 10 to 13% where the slimes have been included in the feed. In another plant, the same unit, with 60% of the minus 200M material removed from the feed, achieved a cake moisture of around 6%.

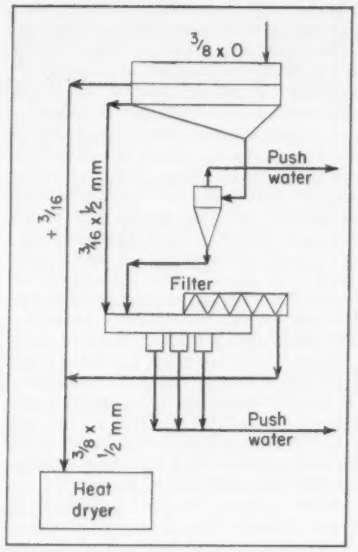
Maintenance also has a major bearing on the results of centrifuging. Proportions and clearances are carefully designed for maximum efficiency. Frequent maintenance, rather than letting renewable parts run to destruction, keeps the moisture in the output at a minimum and thus increases acceptability without further treatment or makes

the cost of subsequent thermal drying appreciably less.

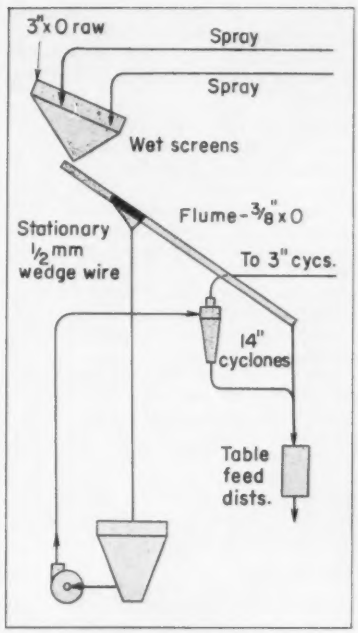
FILTERS—With the increase in pressure to reduce stream pollution, and also as a result of the growing use of other types of mechanical dewatering equipment producing effluents containing fine material, there is an increased trend toward the installation of filters of the continuous-vacuum type. As a corollary, a solid-bowl centrifuge especially designed for the service, known as a "polisher," is used for the same purpose.

Among the vacuum filters the drum type, and especially those with top-feed reservoirs, can handle coarser solids but require considerably more floor space.

A recent addition to the types of filters employed in coal preparation is the horizontal vacuum unit. Since it employs gravity, vacuum is not necessary to hold the cake in place and power requirements consequently are low. Also the operation is visible and controllable throughout the entire cycle. Its use in a cycle involving preliminary cyclone dewatering and final heat drying (⅜x0 feed) is shown in an accompanying flowsheet. Other flowsheets with disk-type equipment are included with a later section on "Water Handling."



HORIZONTAL VACUUM FILTER in this flowsheet is preceded by cyclone. Filter product goes to thermal unit for final drying.

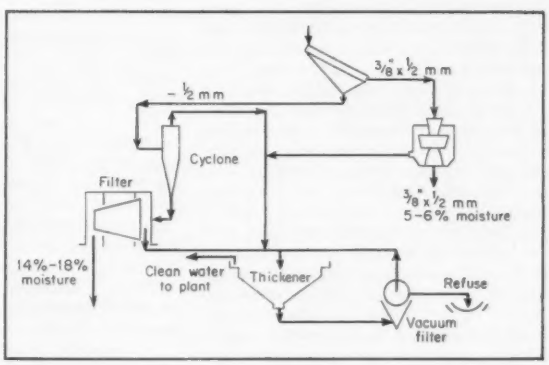


SIMPLIFIED DESLIMING ahead of tables by fixed screen in flume.

FINAL MOISTURES—With the vacuum type, flocculation of the fine-coal particles by means of caustic starch or some other agent increases filter capacity and reduces moisture in the final cake. However, some experience abroad has indicated that starch-type flocculants can result in difficulties in flotation where the filter effluent is recirculated. For a report on how flocculation increases filter capacity and how to select a flocculant, see *Coal Age*, December, 1957, p 74.

Final surface moisture of the filter product is held to reflect largely the moisture in the feed, the percentage of minus 200 to 325M material and the ash content of the dried product, though feed moisture apparently is less of an influence than the other two factors. Depending upon percentage of fines and ash, surface moisture in the product ranges down to as low as 15% and up to approximately 30%, with some exceptions both above and below. For a complete discussion of selecting and operating disk-type filters, including factors affecting filtration rate and moisture removal, see *Coal Age*, January, 1955.

AUTOMATIC FEED CONTROL—The accompanying diagram shows the automatic feed-flow control used at one plant to get a full cake at all times, prevent recirculation of solids, relieve the operator for other duties 90% of the time, and attain uniform cake moisture (*Coal Age*, October, 1957, p 106). Differential probes in the underflow sump, conditioner and filter tub control valves which in turn control slurry flow.



SOLID-BOWL HORIZONTAL CENTRIFUGE supplements vertical unit in this circuit also including cyclone, thickeners and vacuum filter for refuse.

Thickening and Desliming

Since large volumes of water complicate the final drying job—whether in mechanical or heat equipment—and since very fine material decreases the capacity and efficiency of both mechanical and thermal units, the trend today is toward thickening or desliming, or both, in advance of drying, as well as in washing, as noted previously.

THICKENING—Reducing the water load on the final drying units may be done by relatively simple means, common ones being fixed sieves or mechanical or electrical screens—usually both—ahead of the drying unit. For even greater water removal, plus also desliming, the equipment that may be employed includes settling tanks, drag tanks, thickeners and cyclones, which may be preceded—and usually are—by fixed sieves and operating screens for unloading.

The cyclone has the advantage of low cost and high flexibility. The settling tank also has the advantage of relatively low cost and simplicity but the degree of thickening may not be as great. Sedimentation in relatively still water is perhaps the ultimate in thickening, and is the province of the usual circular thickener. Although their first cost is relatively high, maintenance and operatng costs are almost negligible and they produce clear water for reuse. To speed settling or to take care of conditions approaching colloidal suspension, flocculation may be employed. Starch is still considered the most satisfactory medium, though, as previously noted, it may result in trouble if the water is recirculated to flotation circuits. This trouble, however, is not encountered with synthetics, which are finding increasing use.

Examples of how most of the units previously mentioned are used are included in many of the flowsheets in this preparation guide.

DESLIMING—Removal of very fine material prior to further drying may be done as the first step in the fine-coal processing cycle, or directly before the material to be dried goes into said drier. Removing clay slimes, as an example, ahead of froth flotation keeps reagent consumption low. Removal of extreme fines ahead of tables is another growing practice.

Examples of desliming in various types of circuits may be found in several of the flowsheets included in this section. Equipment includes the riffle screen, standard vibrator, settling cones, drag tanks, bowl-type desilters and cyclones, as well as classifiers of the

nydraulic and rake types. In some instances, as in conditioning feed for tables, the drag tank frequently employed may be replaced by a simple stationary screen in a flume (see diagram).

WARM-WATER PROCESSING—Water is easier to shake or spin off when warm. Advantage is taken of this fact at one plant (*Coal Age*, December, 1955, p 70), where dust is removed from the dryer exhaust by a combination of cyclone collectors, and water sprays are used to cut down the speed and volume of the exhaust to atmosphere. Two cyclones are provided for each of the four dryer exhausts, after which the gases go to a concrete duct leading to a silo chimney.

Sprays in the concrete duct reduce gas temperature from approximately 180 down to 110 F. The warmed water, with its temperature raised about 45 F, is returned to the fine-coal washing circuit, raising its temperature by up to 13 F in winter. This warmer washing water and resulting warmer coal facilitates mechanical dewatering, apparently by reducing surface tension.

Heat Drying

Heat drying is about the only way to get surface moistures of as low as 2 to 3% consistently, particularly with the finer sizes.

DRYER TYPES—Types of heat dryers used in coal mining are:

1. Rotary, with either inner and outer shells, or an outer shell with lifting vanes inside. Newer type units are designed for outdoor operation and coal-dust firing.

2. Reciprocating screen, which also acts as the carrying medium. In most instances, the gas is pulled down through the bed and the drying action is of two types; evaporation and, to some extent, mechanical as a result of the screening action and the scrubbing action of the gas. When the gas flow is interrupted by an appropriate valve and then is resumed, squeezing also takes place. As the coal gets finer, evaporation becomes relatively more important, and consequently, fine-coal screen driers are designed for longer coal retention as a rule. New designs include a step between the two screens to turn the coal over.

Top size varies from as low as ⅛ with the fine-coal units up to 2 or 2½ in. Depending upon size of the unit, and also the size of the coal, capacities of screen-type driers normally range from 25 to 125 tph of dried product.

3. Cascade, in which the coal flows down in steps. Units employing the cascade principle usually are fitted with revolving shelves or trays in a round vertical shell. The coal is plowed or otherwise moved from one tray to the next in the drying process, which is largely based on convection. By tempering the incoming gases and by mixing them with the circulating air in certain types, the gas temperature at the point of contact with the coal can be cut to as low as 150 F.

Depending upon type and design objectives, dryers of this type handle coal with a top size ranging from ¼ or ½ in up to 2 in, with some more suited to handling certain size fractions, such as, 2x½.

In another unit employing the cascade feature, coal is carried up on conveyor pans, or louvres, cascading down repeatedly while it works its way from one side to the other. Top size ranges from ¼ or ⅜ up to 1 in.

4. Conveyor or carrier, in which the coal is moved through a hot-gas chamber on a perforated carrying strand or a wire-mesh belt. One type provides two stages of drying with both up- and down-draft gas flows.

5. Suspension, also known as "flash," in which the coal is introduced into an upward-flowing gas stream. These dryers are widely used on coal ½ or ⅜x0—sometimes down to 10M or less. One recycles part of the stack gas to the furnace to keep down oxygen content and maintain an inert atmosphere in the dryer. In a second type, part of the dried product can be recirculated if feed moisture is naturally high or as a result of a high percentage of fines. A special trap is available for the latter unit for friable coals. Both also include provision for burning the dust from the cyclones or secondary separators.

6. Fluidized-bed, in which the coal is dried in a reactor in a fluid state. Though originally developed for a top size of ½ in, the units now are employed on sizes up to 1¼ or 1½ in.

DUST SUPPRESSION—Dust is a problem with practically all heat dryers, and particularly with those handling the smaller fines. Cyclones are the first line of defense and may be supplemented by bag-type collectors, wet collectors and water-spray systems (see "Air Cleaning"). High temperatures and high moistures in the spent gas have militated against the use of bag collectors in some instances and resulted in adoption of wet or wet and dry (tumbler-type) collectors.

DRYER SAFETY—Ten recommendations by the USBM for promoting safety in the operation of heat dryers (R.I. 5198) are:

1. Good housekeeping should be stressed to prevent spread of combustible dust and eliminate ignition sources. Adequate vents should be provided, not only on cyclones but on other equipment and in the main structure of the plant.

2. Automatic controls—preferably with alarms—should be provided to shut down equipment if the temperature rises excessively, coal feed is interrupted or gas flow is interrupted.

3. Moisture content of the coal feed to the dryer should be maintained at a uniform level.

4. Temperature charts should be carefuly watched and dryer operators should not tamper with equipment or controls.

5. Controls, valves and other sensitive parts should be inspected frequently.

6. Equipment should not be operated beyond rated capacity and definite upper limits should be placed on permissible inlet and outlet temperatures and the rate of coal feed.

7. Scrubbers and collectors should be placed beyond the cyclones to prevent excessive discharge of dust.

8. Adequate fire protection and firefighting equipment should be maintained in the drying plant.

9. Long ducts, and especially horizontal ones, should be avoided to minimize ignition hazards and reduce surfaces on which fine coal can accumulate.

10. All dryers, conveyors and other dust-producing equipment and transporting machinery should be made as dust-tight as possible and operated to prevent dust leakage.

Crushing

Arrange facilities for requisite flexibility and choose units producing the desired sizes with a minimum of fines.

ALTHOUGH CRUSHING or breaking for market purposes can take place in the preliminary processing, as in reducing the top size in the mine-run feed to a certain dimension, the majority involves specific sizes after hand picking or other cleaning and the goal usually is the production of stoker or other smaller sizes. An exception is anthracite, where practically all of the breaking is done in one or more stages before the coal goes into the cleaning units.

In bituminous plants, a favorite place for cleaned-coal crushing equipment is between the top and bottom strands of the mixing conveyor. This permits a wide flexibility in the sizes that may be run to the crusher, and also provides a convenient means of getting the crushed product back to the loading point, especially when the product is loaded without further sizing or other treatment.

Crushing may be—and frequently is—a part of a breaking and rescreening cycle for the production of double-screened stoker or other sizes, such as pea (see "Rescreening").

FINES LIMITATION—A major goal in clean-coal crushing operations—or, in preliminary breaking for the same purpose—is reduction to the proper size without exessive production of fines. Crusher design is one answer, and types and models now available permit good attainment of this objective. Operation is another answer and, among other things, involves stage crushing with rescreening between each stage. Some plants use as many as three or four crushers in series with vibrating screens between to unload the fines, which otherwise would result in increased grinding and pulverizing.

Rescreening

THE VIBRATING SCREEN, normally receiving its feed from the main sizing shaker is the most-used type of rescreening unit in the bituminous fields. Air also has been used for dedusting at say, 48M, in making the smaller stoker sizes. Rescreens also are quite commonly hooked up to receive material from cleaned-coal crushers when the natural output of the mine is not sufficient to meet stoker and other specialty demands.

Mixing, Blending

MOST of the mixing is done in the old reliable mixing conveyor. Unless crushing is introduced into the circuit, the mix is a natural one—in other words, the sizes in the mix are present in the percentages that naturally come from the final sizing screen.

"Prescription" mixing is a relatively new method of achieving a size consist in line with the customer's desires. A major advantage is that consists can be absolutely accurate and also absolutely uniform.

Prescription mixing normally is limited to

the smaller sizes designed for industrial or domestic-stoker use. It involves placing the various sizes in separate bins. The sizes may be as they naturally come from the sizing units, or they may be produced in part or entirely by crushing and rescreening. Mixing normally is achieved by feeding the sizes onto a gathering belt ending in a boom section. The rate at which the sizes are fed out of the various bins establishes the percentages in the mix. This rate may be adjusted by adjusting gate openings, but is considered less accurate than special feeders equipped with variable-speed drives.

Dustproofing

Match medium to coal and apply carefully for effectiveness and economy.

THE PRINCIPAL MATERIALS used for dustproofing coal are oil, calcium chloride and special chemical compounds, usually containing calcium chloride with other substances added. Calcium chloride and other materials pick up water from the air and thus provide a moist surface to which the dust adheres. Corrosion-inhibitors may be added to the chemical-type dustproofing agents to prevent possible attack of metal firing equipment and coal-handling parts.

Spray oils for dustproofing are available in a wide range of characteristics to fit the job being done. Equipment for applying them includes both heating equipment for spraying hot, and high-pressure atomizing, or "cold-oil" equipment for spraying cold. With the hot-oil systems, the oil-carrying lines may be paralleled by heating lines carrying steam or hot oil to keep the oil at the proper temperature.

QUANTITY AND TYPE—Quantity of material necessary to achieve a desired degree of dustproofing depends upon both the size and type of coal being treated. Since the treatment is a surface job, and the surface to be treated increases as the size of the coal decreases, more material must be applied to the finer sizes. Porosity and other mechanical characteristics of the coal also influence both quantity and type of dustproofing material. With some very porous coals for example, good treatment with an economical quantity of petroleum-base material requires going to a very-high viscosity to prevent absorption of the material into the interior of the coal. Most of the high-volatile coals, however, may be treated satisfactorily with oils having a viscosity of around 200 deg.

APPLICATION—For maximum effectiveness with a minimum quantity of material, dustproofing material should be applied while the coal is in the air. Use of properly designed hoods prevents waste and insures maximum treating efficiency. Normally, such hoods are placed at the ends of loading booms or chutes, but they may also be placed over conveyors and other equipment, particularly those handling the larger sizes. The proper design of nozzle and the proper temperature at the point of application are key factors in the use of hot oil, and nozzle design is likewise important with other types of material to insure good treatment with minimum material quantities.

Regulation of material flow to the flow of coal may be accomplished by such steps as paddle-controlled valves at the ends of booms and chutes. The position of the valve is controlled by the thickness of the coal stream and in turn increases or decreases the flow of dustproofing material, preventing both overtreatment and undertreatment.

Freezeproofing

Unless drying is done consider to avoid customer troubles in cold weather. Apply carefully for effective results at low cost.

WHERE HEAT DRYING is not the practice and mechanical drying does not provide sufficient moisture reduction to prevent freezing, the coal may be treated with chemicals or oil. Such treatment usually is required with slack, screenings and other small sizes. The need for treatment is affected not only by the climate encountered but by industry custom and customer preference.

Salt and calcium chloride, usually applied dry, are the two main chemicals used for freezeproofing. The quantity depends upon the expected temperature and the moistness of the coal. For calcium chloride, the Calcium Chloride Institute offers the following guide:

Lb CaCl per Ton at Specified Temperatures, Deg. F.

Moisture	+32 to +15	+15 to 0	0 to —15
3%	3.0—4.5	4.5—6.0	6.0—7.5
6%	6.0—9.0	9.0—12.0	12.0—15.0
9%	9.0—13.5	13.5—18.0	18.0—22.5

Chemicals may be thrown into the car by hand or may be dispensed by mechanical feeders into the coal stream as it is loaded. The latter normally provides more uniform and more accurate treatment.

Oil is finding increasing application as a freezeproofing agent. One operation, as an example (*Coal Age*, February, 1956, p 75), uses an 80-sec oil at the following rates: ¼x0 centrifugal carbon, 6 qt per ton; 4x2 or 2x1¼ crushed to 1¼ or ¼ in, 2 qt; 1⅞ 28 M mix, 3.4 qt at a cost of 0.084c per ton. In loading coal under 1¼ in in size, the inside of every hopper is sprayed with 6 gal of oil for a 50-tonner and 7.6 gal for a 70-tonner at a cost of about 1c per ton.

Loading

Plan systems for flexibility and reduction in manpower.

ANTHRACITE is loaded into railroad cars almost entirely from storage pockets, reducing the number of loading tracks to one or two for many plants. Early bituminous practice was to provide a track for at least each major size. Now, as in anthracite, the bituminous trend is toward loading on as few tracks as possible. Methods of reducing the number of loading tracks to a greater or lesser degree include:

1. Storage pockets. Such pockets, receiving coal by conveyor, may be above or below the normal loading point. Thus, a second size—stoker as an example—can be loaded.

2. Two-way chutes. Dual conveyors, as an example, deliver two sizes to two-way chutes, one for each track. By combining through gates, the number of sizes to the two tracks can be increased to three.

3. Elevated shuttle belt. Where only one size is loaded, or where storage facilities are provided for one or more additional sizes, loading of up to an entire shift's run can be done without moving a car once the trip is set in (*Coal Age*, March, 1953, p 94; October, 1957, p 76).

4. Automatic shuttle belt. In one example of the use of this equipment, the belt is mounted between parallel tracks. Empties are placed on one of the tracks and the belt travels from one to the other, loading them in sequence. It then switches to the parallel track and works back while the loads are being replaced with empties. If there is a gap the belt will continue to travel along one side and cross over to the other to try to find an empty. If it can't it shuts the plant down—automatically—until empties are placed.

CAR HANDLING—Mechanical retarders provide positive control of car movement in loading, and there is a growing trend toward the use of motorized equipment, including special hoists which permit pulling a car back uphill if desired, or moving it back and forth several times to load the coal in layers.

Hoist-type retarders, incidentally, save overshooting and runaways, and consequently eliminate delays ranging from several minutes up to, where a column may be knocked out, several days.

Automatic dropping and loading of cars is now coming into the picture. At one of the first installations (*Coal Age*, June, 1958, p 94) the system involves hoists with double ropes and sensing switches to control car movement, transfer of coal flow from one to another, and uniform loading without the attention of an operator.

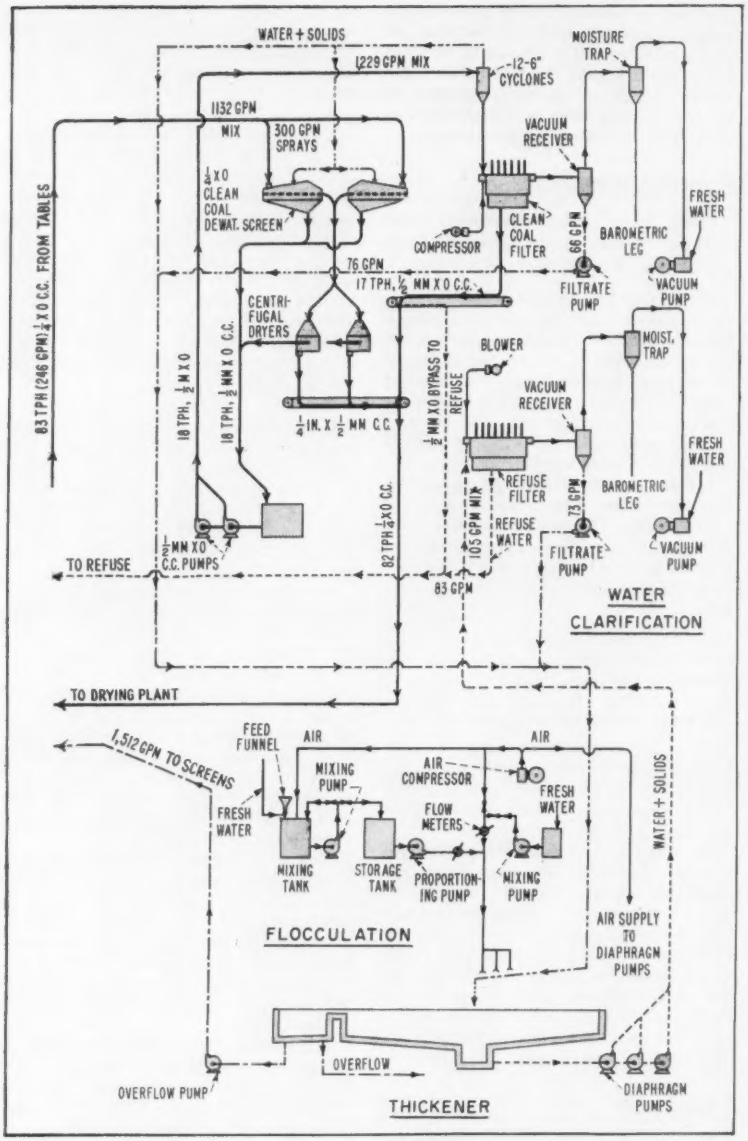
Gravity and electro-pneumatic retarders are employed in another system with varying degrees of automaticity. In one such installation (*Coal Age*, February, 1959, p 118), some 720 tph is loaded on one track. At another (*Coal Age*, July, 1959, p 80) one man at the dump controls the spotting and loading of some 20 to 30 cars an hour on four tracks.

Labor Savers. Where full automaticity is not possible, providing car droppers with bicycles, electric jeeps and other types of wheeled equipment save walking time and labor and make them more effective.

Clean-Coal Storage

Stockpiling clean coal is a growing practice at bituminous mines, as well as anthracite. The favored place is on the ground, though some silos and bins are employed. Bin capacity ranges up to 2,000 tons or better; ground capacity, 250,000 tons or better. With large stockpiles, belt equipment is used in almost all instances for both stocking and reclaiming, with the reclaiming unit usually placed in a subway under the stockpile.

Piles may be single conical, laid down by a fixed-discharge conveyor; curved, laid down by a pivoting stacker conveyor; double conical, laid down by separate piling booms fed through a flygate, or by a reversible stacking belt; or long and narrow, laid down by a belt with traveling tripper. Lowering spirals or ladders are employed to reduce breakage where piling booms are not employed.



WATER-CLARIFICATION CIRCUIT at one new property involves a combination of cyclones, thickeners, centrifuges and vacuum filters.

For a detailed discussion of prepared-cone storage and loading facilities, see the *Coal Age* Operating Guide, "Mine Storage of Coal," December, 1960, p 105.

Truck Loading

It is possible to load trucks over the tracks or by chutes brought out from the plant but this, among other things, makes it impossible to service trucks except when the plant is running. Consequently, the usual practice is to provide bins or pockets for sizes sold to truckers. Spiral lowering chutes prevent breakage in filling bins holding the coarse sizes, and degradation in handling through the bins is removed by fixed screens in chutes, or by small shakers or vibrators.

Late truck-loading plants include, in the bituminous field, a multiple-silo installation in which the coal is distributed to the pockets by a pivoted elevated belt, which is swung on a curved track from one pocket to the other for filling purposes. Trucks are loaded through chutes.

In the anthracite field, a six-bunker plant is designed so that all operations are conducted by two men and accurate dispensing of orders is controlled by presetting dials to control flight feeders delivering at rates up to 5 tpm (*Coal Age*, January, 1954, pp 68-69).

Barge Loading

Barge-loading plants fall into about five classes, as follows:

1. A simple dock from which trucks dump into the barge at times when water conditions permit.

2. The stationary-chute type, which is simple and low priced and works well where river fluctuations are not too great and banks are steep.

3. Elevating-boom type, with barges moved back and forth in the river beneath. The elevating boom allows more loading time if river elevation changes greatly. This type is advantageous where the bank of the river is considerable distance from the channel and the elevating boom and conveyor belt can be combined for travel across the flood plain.

4. Floating-barge type, with the loading boom mounted on a floating, or spar, barge and pivoted for easier loading. Requires a steep bank or fill to permit retraction and extension of the main conveyor with changes in water level.

5. The tripper-conveyor type, in which the barges are stationary and the loading chute moves back and forth to load and trim. Nothing has to be done to the barges but load them.

For examples of most of these types see (*Coal Age*, December, 1956, p 58; also October, 1956, p 60; June, 1957, p 74; January, 1958, p 76).

TRAMP-IRON REMOVAL—Removal of tramp iron is handled at a number of plants, even though all sizes are washed, by suspended magnets or magnetic pulleys at the point the raw coal enters the plant. If washing or removal in the raw-coal stage is not practiced, iron removal should be done in the loading stage, especially with coal designed for stoker use. Facilities include magnets designed for use in the bottoms of loading chutes, as well as other types of units.

DEGRADATION REMOVAL — See "Clean Coal Sizing."

Water Handling

Proceed on the basis that no discharge to streams will be permitted in the future. Assure ample supplies of fresh water and treat if acid.

QUESTIONS involved in water handling at plants cleaning by wet methods include:

1. Fresh-water supply and treatment for plant use.

2. Clarification and recirculation of process water.

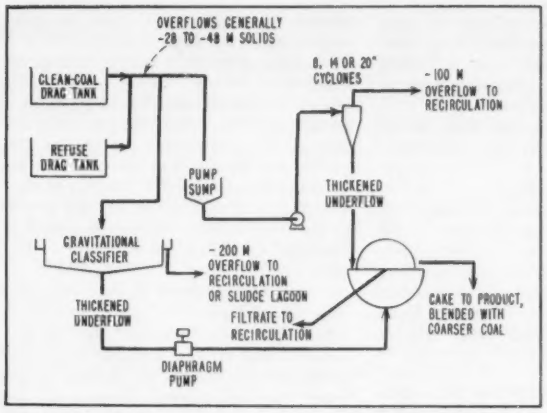
3. Final disposal where circuits are or cannot be closed.

Makeup water requirements vary with the type of circuit. In a fully closed circuit, where sprinkling at the face results in an average of 5% surface moisture on the raw coal, which is the same as the average for the shipped coal, it can be seen that fresh water cannot be added. Normally, the only clear-water applications would be on pump glands and certain other essential applications. In an average plant, under these conditions, makeup water might well be only 50 to 75 gpm. In an open circuit, it might well be several times that minimum.

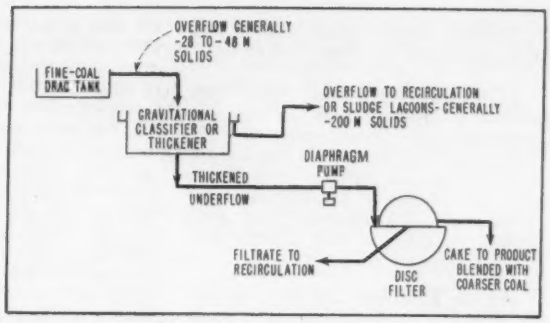
Sources of makeup water are:

1. Deep wells.

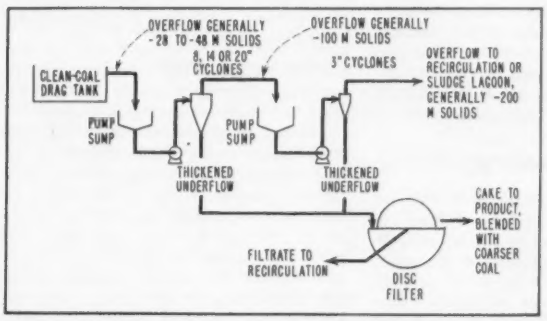
2. Surface water from lakes, ponds and streams, or from reservoirs made by dams to catch surface runoff.



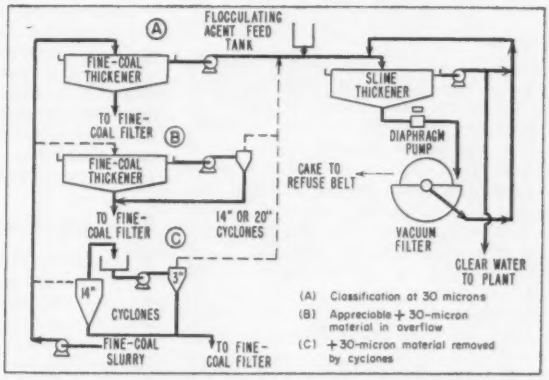
SOLIDS REMOVAL from wash water by flocculation and filtration, with variations to meet varying conditions.



VACUUM FILTRATION with cyclones for preliminary classification of feed.



VACUUM FILTRATION with gravity classifiers or thickeners for preliminary classification of the feed to the unit.



VACUUM FILTRATION with gravity thickeners and cyclones for preliminary classification of the feed before filtration.

3. Mine Water if available and suitable.

TREATMENT—Water from deep wells normally can be used without treatment. Mine water, on the other hand, may be quite acid though there are exceptions. Surface water may or may not be acid, and may at times be contaminated by mud. Some authorities hold that the pH value of the water in the plant circuit should be between 8.0 and 8.5.

Other operators, however, feel that slight acidity is not objectionable. However, if the water is very acid, treatment with lime or soda ash is in order. Treatment permits plain steel for example, to be used instead of alloys, resulting in substantial savings in cost of equipment and materials, in replacement labor and in shutdown time. Even if the makeup is only mildly acid or neutral, acid may build up in the recirculated water and need treatment for that reason alone. Automatic equipment is now available for treating water efficiently and at minimum cost.

Unless there is an assured minimum flow adequate for plant need at all times, storage should be provided to tide the plant over periods of reduced flow.

Handling Wash Water

Stream-pollution regulations and the need, in many instances, for decreasing the loss of good coal to the refuse have resulted in major activity in the processing of wash water. A third reason for processing is to prevent the buildup of solids in water recirculated to washing units, since excessive buildup may materially affect the gravity of separation and consequently cleaning results. Available data indicate that many preparation men regard a solids content of more than 15 to 20% as excessive, while some try to keep it under as low as 5%.

Closed circuits frequently are mentioned as objectives in water handling—and are practicable in some instances though not in all. Reasons for circuit closing include: (1) elimination of discharge to streams, (2) reducing makeup water to that required for pump glands and other essential uses, (3) recovery of coal and (4) recovery of medium. As a corollary of closing, however, it is necessary to remove at least part of the solids, especially if clay and mud are present, to prevent solids buildup and a change in the gravity of the bath.

THE WHY OF BLEEDING—Closing a circuit may either be impossible or not desirable, however. If, as previously indicated, moisture on the coal leaving the plant is equal to that entering the plant, the quantity of makeup water that can be added without bleeding is nil. Thus, even gland-water requirements, if included in the water circuit, can force bleed under some circumstances. Some circuits, however, have been closed successfully, and this trend is more in that direction.

Practice and field custom also may result in bleeding of some to considerable quantities of wash water. It may, as an example, contain large quantities of high-impurity fines that would be difficult to clean. And under some conditions, it may be necessary to feed excess fresh water into the system for essential services, even if it is not required to rinse off clean coal and improve appearance as it might be in some instances.

Also, complete closing in the sense of allowing no escape of either coal or water may become impossible if certain steps are considered desirable in the preparation process—for example, desliming at 325M. The slimes must go somewhere and it is not always practicable to prepare them so they can be put in with the clean coal or the refuse.

Since bleed therefore becomes necessary in the majority of instances, the sludge pond also becomes necessary if discharge of solids to streams is to be prevented. Where employed, the pond should be operated to prevent the overflow of anything but clear water.

In one instance, a baffled concrete tank is employed as a pond substitute (*Coal Age*, January, 1960, p 92). An overhead hoist facilitates removal of accumulated solids as necessary.

SOLIDS REDUCTION—The goal in this operation, in contrast to fairly complete removal to meet pollution regulations, for example, is keeping the solids content of recirculated water to a reasonable figure; not over, say, 15 to 20%.

Facilities include setting cones, drag tanks, sludge ponds, cyclones and so on.

FLOCCULATION—Where natural settlement is depended upon for removing solids from wash water, results reflect the size of the material, the time provided for settlement, and the degree to which disturbance can be reduced. Flocculation of the material promotes settlement, and some types of thickeners are built to permit flocculation along the settlement.

SOLIDS REMOVAL—Complete removal of solids may be desirable for two reasons: (1) salvage of good coal from the wash water, or (2) conformity with pollution regulations. Where coal is concerned, the same installation ordinarily accomplishes both results. Where refuse is involved, the only goal is meeting stream-pollution regulations.

Settling ponds, where space is available, are perhaps the simplest method of attaining sufficient solids removal to conform to pollution regulations. In some instances, they may be the cheapest, though not always. Their construction involves some expense, and if the capacity is limited they must be cleaned out from time to time. With ponds also, any fines that reach them, if of good quality, are either lost or can be recovered only at some added expense. Consequently, there is a trend toward extracting at least part if not all of the solids from the water before running it to the pond.

Equipment for accomplishing some solids removal before discharge to the pond may be merely the old reliable conical or drag-conveyor settling tank. Other units are thickeners, hydraulic or nonhydraulic classifiers, cyclones, and filters of various types. Combinations also are employed to meet specific conditions.

FILTER CIRCUITS—Three variations in a solids-removal flowsheet involving flocculation and complete closing of the circuit (*Coal Age*, January, 1955, p 76) are shown in an accompanying illustration. The goals are economical operation and removal of the solids so that they can be handled the same as any other solids, whether coal or refuse. Variation A is recommended where the fine-coal circuit includes a gravity classifier effectively classifying at 30 microns; Variation B, where gravity classification is such that an appreciable quantity of plus 30-micron material is found in the overflow; and Variation C, where the equivalent of two-stage cyclone concentration is employed.

Three water-handling systems based on filters for final recovery of the solids also are shown in the accompanying illustrations. They are suggested for use where clay slimes are not excessive and closed-circuit operation can be obtained by filtration, or where the large slime fraction is bled off to a sludge pond. The three systems involve:

1. Cyclone classifiers in conjunction with gravity classifier or thickener delivering thickened underflow for filtration.

2. Cyclone classifiers in conjunction with filters. The two-stage system shown may be employed (1) where solids under 100M are too high in ash to be included in clean coal and (2) all underflows from both stages are filtered as clean coal. A buildup of minus 100M in the circulating water is prevented in both instances.

3. Thickeners and cyclones for preliminary concentration. Better filter operation is one of the advantages.

How filters are used in a circuit also including dewatering screens, thickener with flocculation, and cyclones is shown in another illustration. The system functions on ¼x0 and the final products are clean coal, refuse and clear water to the raw-coal shakers or to overflow. Thermal drying completes the job (*Coal Age*, October, 1957, p 76).

WATER CIRCULATION — Head tanks with automatically controlled pumps provide a uniform head on washing equipment, with consequent increase in the efficiency of separation, particularly with jigs.

Handling of casual and spillage water is simplified by proper design of the basement floor, which should be equipped with drains leading either to the pond or to a recirculating-water sump. Cleaning up by washing down is facilitated by such construction.

Sludge Recovery

NORMALLY, water clarification and the recovery of fine coal go hand in hand, although if clarification only is the goal the material may only be routed to the refuse bank, particularly if it is refuse in fact. However, the percentage of material finer than, says, 10 or 28M, may be substantial at many plants and may warrant recovery for its own sake.

The equipment for recovering sludge from wash water, as noted in the preceding section, includes: settling cones and tanks, and thickeners and filters, along with hydraulic and nonhydraulic classifiers and cyclones. Cleaning equipment includes flotation units and special fine-coal washers, followed by normal dewatering and drying.

The preceding envisions recovery of the sludge as it is produced in the plant. Another form is recovery from old silt or sludge ponds or banks. Recovery equipment includes conventional shovels and also floating dredges. At some installations, the final step consists of drying. A modification, where the nature of the material warrants, is centrifuging to throw out the fine impurities and then heat drying. Where cleaning is considered desirable, a number of large plants have been built for froth flotation.

Refuse Disposal

Tailor system to the job and dispose to avoid firing, stream pollution and the like.

THE DUMP TRUCK has taken over a large part of the refuse-disposal job in the coal industry today. Its advocates cite low cost and maximum flexibility, especially where it does not have to surmount too-heavy grades. The aerial tramway lends itself not only to disposal in what might be called normal territory but also to taking refuse across hills into neighboring valleys and the like. The side-dumping or revolving larry, in addition to ordinary situations, also is used to build out from hilltops or hillsides from bins fed by belt conveyors, tramways and the like.

Pumping of refuse is growing, though the question of taking care of the water to prevent stream pollution comes in. In some instances, it has been possible to pump into old mines or worked-out sections. The pumps will handle rather large pieces but normally pumping requires crushing to a top size of 2 or 3 in. Usually top size is held to not over ¾ or 1 in by prescreening or crushing, keeping down line velocity and cost.

Even where pumping is not involved, it may be economical to crush, particularly where large rock is involved. Jaw or gyratory crushers may be indicated under such circumstances. Benefits of crushing include easier handling, a more compact pile and greater ease in maintaining a running surface where trucks are used.

Where refuse output is large, and especially where trucks and similar equipment are employed, a bulldozer for spreading and compacting may pay off.

FIRE PREVENTION—Prevention of firing of refuse dumps has been the subject of considerable research in recent years, and the spread of automotive haulage has made possible new and effective methods of piling, compacting and sealing refuse to practically eliminate firing. One method of layering, compacting and sealing against air is described in *Coal Age*, June, 1951, p 91. Development of the method also was accompanied by steps to extinguish an old fire by stepping, trenching and filling and covering with earth as conditions dictated.

POLLUTION PREVENTION — New and more stringent pollution regulations now make it advisable to place refuse so that no solids can be washed into streams; also, if possible in view of the tightening of regulations, no acid.

Power

VOLTAGE—Accepted voltage for most of the stationary motors in preparation plants is 440, leaving in most instances only the question of whether 2,300 V should be used for certain large units, such as pumps, crushers and the like. A rough rule is that motors of 100 hp and larger should be 2,300.

TRANSFORMER LOCATION — Packaged substations with oil-filled transformers are available for outdoor service, with nonflammable units for indoor. Outside is the place for the transformer station if the highline voltage is over 10,000 and the reduction to 440 is made in one step. If the supply voltage is less than 10,000, the packaged indoor substation with nonflammable transformers is the general choice.

CONTROLS — Starters grouped in factory-assembled control cabinets are now standard for preparation plants. One central cabinet is satisfactory for a small plant, but a large plant may require cabinets at several locations to keep the motors reasonably close to the starters. Draw-type starters which can be pulled out for quick replacement are coming more and more into favor.

Dust is one of the major problems in lo-

cation and operation of starting equipment. The best solution seems to be one or as few control rooms as possible made fairly airtight and fitted with blowers to maintain a slight positive pressure inside the rooms. Air forced into the rooms should be filtered.

CAPACITORS — The induction-motor load of the preparation plant produces a low power factor, which adds to the bill and heats conductors and motors. Capacitors should be installed in the plant to bring the lagging power factor up to unity. Theoretically, an appropriate capacitor should be placed at each motor. However, practical limitations of cost, space and maintenance generally make it advisable to group the capacitors in the control room.

Maintenance

Emphasize corrosion- and abrasion-resistant materials, equipment and designs.

MAINTENANCE is necessary because of wear and corrosion inevitable in operation, and the effects of the elements, for example:

1. Rusting of the exterior and interior, including structural members and equipment, as a result of rain, snow and water.

2. Corrosion from acid water and, on occasion, from the gases given off by burning refuse dumps.

3. The effects of heat and gases involved in heat drying.

4. Wear from the handling of coal and rock.

5. Lack of lubrication, overloading and other abuse, faulty electrical service and the like.

All wear and corrosion cannot, of course, be eliminated. Use of the proper materials and proper designs when a plant is built, or when parts or sections are added or replaced in existing plants, are major factors in maintenance cost. These materials and designs include the following:

1. Location of heavy equipment, particularly of the rotating or reciprocating type, on or as near ground level as possible, cuts structural cost and reduces the effects of weight, motion and vibration.

2. Bracing, steel weight, balancing and damping to provide stiffness, reduce or eliminate unbalanced forces, and prevent the transmission of motion and vibration to the structure.

3. Use of protected steel and special roofing and siding materials, including asbestos-cement, aluminum and stainless steel.

4. Protective coatings and paints for steel exposed to rain, moisture, gases and the like.

5. Neutralization of acid water with lime or soda ash. Automatic feeding equipment now available facilitates this job. Frequently, neutralization will make it possible to get much-longer life from ordinary steel, saving both in material cost and replacement labor.

6. Use of corrosion- and abrasion-resisting materials for screens, chutes, flumes, water lines, pumps and so on, including plastic, rubber and asbestos-cement water lines and connections, and rubber-pinch and orifice-type valves. Stainless steel for bolts, for example, can solve some annoying corrosion problems in certain preparation applications.

7. Use of linings to resist wear and, with some types, corrosion. Examples include glass, tile and brick in chutes; and rubber, plastic, sand-cement and ceramic linings for tanks and cones. Another form of lining is special hard metal for conveyor bottoms. Hard-surfacing of wear points or the use of special wearing strips are natural steps.

8. Use of totally enclosed, splashproof and other special motors for dusty, wet and similar locations, plus moisture- and dust-proof controls or the location of controls in rooms with blowers using filtered air and maintaining a slight positive pressure inside the rooms at all times.

9. Good lubrication with proper equipment and quality lubricants of the correct types applied at the correct intervals. Centralized automatic systems are growing in favor.

10. Regular inspection and cleaning of preparation equipment. Cleanliness and good housekeeping for the plant as a whole naturally supplement these, and to facilitate housekeeping a growing number of plants are being equipped with hoods and covers for certain equipment connected to exhausting and dust-collecting equipment, plus vacuum systems for cleanup.

Quality Control

Provide or contract for necessary sampling and test facilities for an accurate running record of shipment quality.

Set up for accurate control of plant operation.

CHECKING and control measures are both visual and mechanical or chemical. With lump, for example, the bulk and weight of a proper sample, and the increased difficulty of getting a representative sample, make mechanical and chemical tests difficult, and reliance must be placed largely on visual inspection. In washing, visual inspection—by operators who know their business—of the feed and draw material can reveal changes in condition immediately and permit adjustments to be made promptly, although this type of checking is subject to the normal human frailties.

Even with mechanical and chemical methods, the change in conditions takes place before the results are available, thus re-emphasizing the importance of adjusting operating conditions to provide the desired results as nearly automatically as possible. However, even though the data are obtained after the fact, mechanical and chemical tests are necessary to provide positive evidence of whether or not the desired results are being attained and permit adjustment if not.

SAMPLING—Where the tonnage is at all large and a careful check on quality is essential, one or more specialists should be charged with the responsibility of collecting samples. Depending upon the control setup, they also may run sink-and-float tests and prepare samples for more-elaborate chemical tests of the coal.

Number of samples and sampling intervals depend upon control and quality data required. Egg and lump—and perhaps nut and pea—may be sampled at longer intervals and perhaps only once a shift or longer. The problem grows more critical with the smaller sizes, especially where sales are made on a specification basis. As a result, many plants sample stoker and screenings, as examples, at intervals of as small as 15 min, while every hour is fairly common practice.

Automatic samplers installed at transfer points, especially for the smaller sizes, reduce the labor involved in sampling and tend to increase the accuracy. Manual methods include the car sample taken at a number of spots, but the trend today is toward cutting samples out of the coal as it flows into the car. A convenient method is to mount a narrow box of the requisite length and depth on a pivoted arm which is swung through the coal stream.

If the sample is intended for chemical analysis in the laboratory, time and labor can be saved by placing the preliminary sample-preparation equipment-crusher, splitter and the like—at or near the point the sample or samples are taken. As an example, some plants have provided platforms alongside the loading booms for sample preparation.

TEST PROCEDURE — Samples for checking cleaner operation normally are processed by sink-and-float. The equipment may be on the cleaning floor or at some other convenient location in the plant. The weight of the sink in a standard sample of cleaned coal is a working indication of how the cleaner is performing. The results also may be converted into fairly accurate ash figures by reference to a curve based on the average results of analysis of a representative number of samples.

Checking the efficiency of washer operation also requires testing of refuse.

More precise results of course can normally be expected by laboratory procedure, although the time interval necessarily is longer. Equally or more important, the laboratory is the only means of attaining all the chemical and physical data on both processing results and the character of the shipped coal, including ash, sulphur, moisture, heat content, fusion and softening temperatures of ash, and so on. Also, the presence of laboratory facilities permits research into suggested changes in preparation procedures and forecasting of results. Therefore, more and more plants are being supplemented by well-equipped laboratories (*Coal Age*, July, 1959, p 80, as an example).

SIZING CONTROL—Since the accuracy of screening can have a major effect not only on realization but also on customer acceptance, quality control must take in size checking also. Facilities will vary with the circumstances at the individual plants but they should at least include a test-screen unit.

RECORDS — The type of records kept for operating and quality-control purposes should provide for putting down the data obtained in a form that will make it easily available to and usable by operators, supervisors and other interested persons. Graphic presentation by curves may be a part of the record system, and the data to be entered may include such things as valve settings on washers. For shipments, the record may show car number, size, ash, sulphur, heat content, moisture and so on.

Prescription Maintenance For Production Stability

Initial Target

Prevent or at least minimize production breakdowns by proper maintenance organization, including a preventive-maintenance program and "maintenance engineering" practices.

Key Objectives

1. Establish sufficient maintenance services and facilities to aid in keeping production costs down.
2. Improve maintenance methods and allocation of men and materials to reduce the cost of maintenance services and facilities.
3. Set up maintenance-management practices to keep costs within established budgets.

Key Approaches

1. Plan and supervise methods of equipment inspection, preventive maintenance, emergency and running repairs, equipment replacement, and scheduling and overhauling of equipment.
2. Provide and distribute AC and DC power, communications, compressed air, water and other required utilities.
3. Conduct maintenance-training programs and provide consulting service for management, production supervisors and maintenance personnel.
4. Establish and maintain a system for reporting and recording information regarding equipment, production delays and maintenance costs.
5. Improve equipment design to increase efficiency and safety.

Practice Trends

Industrial engineering playing a major role in maintenance organizations to improve standards and maintenance techniques.

Automatic office machines and computers will assume much of the recording and reporting work load.

"Preventive" maintenance being emphasized as a result of increased use of more complicated and costlier equipment, and to obtain lower production cost.

Maintenance budgets increasing accordingly and will assume an even larger share of coal cost.

More money will be spent on training than ever before as a result of a shortage of qualified maintenance personnel.

MAINTENANCE ORGANIZATIONS, old and new, will undergo numerous changes in the years ahead. Why? The answer is twofold:

1. Machines continue to take over more of the production load and more production capacity is being concentrated in individual machines.

2. The cost, capacity and complexity of modern equipment increases the burden on maintenance departments.

Future equipment designs—those still in the drawing-board stage—provide for controlling the new machines by methods which to date are unfamiliar to the mining industry. Add to these the rising cost of labor and materials for both operation and maintenance, and a well organized maintenance department with qualified supervisors, engineers and technicians becomes a must.

Future maintenance organizations will require "maintenance engineering" to cope with added responsibilities and new techniques. Automation and electronics will assume major importance in the mining industry in the not-too-distant future. These new fields of technology give insight into the future of maintenance and highlight the need for more engineering ability. Electricity, hydraulics and mechanics will require more engineering know-how tomorrow. Consequently, maintenance departments must organize and staff accordingly. Otherwise, production goals will never be reached nor will it be possible to control operating cost.

The importance of maintenance must not only be realized. Follow-through is vital and the first step is to determine what the organization should be and what it should do.

Although the answers to these questions seem obvious, they are often lost sight of in actual practice. But once the cornerstone is in place the building of a maintenance organization can proceed simply and smoothly on a solid foundation. When complete it will provide all the "should bes" and "should dos" that are expected of it.

Maintenance organizations and practices differ within each company, reflecting company policy, type of equipment, size of company, whether the company is engaged in deep or strip mining or both, and the general concept and basic philosophy held by management.

Organization

Obtain full support and understanding from top management on the establishment of an organization and the development of maintenance methods.

Display common sense on the distribution of responsibility.

Analyze the various jobs to be done and then delegate authority. Authority should be defined and contain little overlap to avoid confusion and "buckpassing."

ORGANIZATION is the establishment of authority, responsibility and relationships to achieve the end results. The necessity for applying and emphasizing these factors with regard to maintenance organizations has become more and more apparent with modern-day mining equipment.

Development

A maintenance organization and its program may seem complex when viewed as a whole but when reduced to its component parts it becomes simple and easy to understand. But why is maintenance so necessary? Here are a few reasons:

1. The influence of maintenance on production costs.

2. Effect of output with regard to operating versus breakdown time.
3. Protection and improvement of capital investments.

The establishment of an organization and the development of maintenance methods must have the support and understanding of top management if it is to be successful To obtain this it is necessary to prove the value. Whether support is needed to set up a new organization or improve the services and facilities of an existing program, it is important to present your case or proposal to management showing improvements and justification for the action. The proposal should include, among other things the following:

1. Cost of maintenance in relation to production. This can be shown as a percentage of total cost or in dollars and cents.

2. Analysis of operating time losses due to lack of maintenance and a rundown of where improvements can be made.

3. Data on maintenance productivity in terms of maintenance cost relative to replacement value of repair parts or equipment, or other comparisons which illustrate the point.

Impress upon management that you know your problems and offer the necessary plans, including cost estimates, methods of approach, time tables for expected improvements, etc., for those areas of maintenance to be included in the proposal.

Getting the go-ahead from management to carry out the proposal makes it necessary to take steps to measure, control and improve maintenance methods, facilitate proper allocation of men and material and reduce the cost of maintenance services and facilities. These tools include, among others, the following:

1. Classified Accounts — Simplify paper work and aid in monitoring all areas of maintenance cost and delays.

2. Delay and Work-Needed Reports — Keep management (operating and maintenance) informed of the effectiveness of maintenance and of immediate and future maintenance requirements.

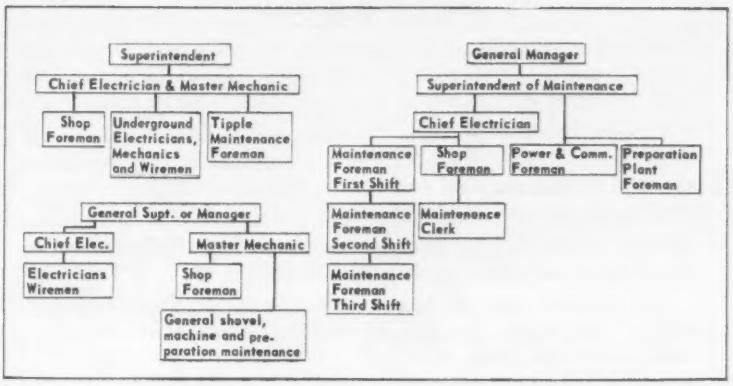
3. Perpetual Equipment Records—Provide data for spotting weak machine components, indicate areas of high maintenance costs and enable maintenance management to determine when machines should be overhauled and when machine components should be changed or redesigned to improve performance and safety.

4. Program Plan and Work Schedule—Enables management to develop an orderly program for scheduling all maintenance work and assigning men so that it can be performed at designated intervals and completed within established time limits.

5. Maintenance Standards — Give management the necessary tools to evaluate work performance, job costs and methods of work procedure.

During development of the maintenance organization specific requirements in the administration of the program should be given priority. These consist of:

1. An organization capable of performing all maintenance functions effectively.
2. An organization chart listing the responsibilities and authority of each maintenance supervisor.
3. A neutral reporting medium for operating and maintenance department heads, including a rigid chain-of-command policy within the maintenance department and between it and the operating department.
4. A preventive maintenance program.
5. An effective cost-control program.
6. A complete report and record system.
7. A good supply system.



SHARED RESPONSIBILITY between operating and maintenance departments facilitates efficient maintenance. Organizations are designed to meet the specific needs of individual companies. Maintenance organizations are assuming a more active role.

Responsibility

There is no single set of rules that can be applied in organizing maintenance systems. However, certain basic principles are necessary. Systems must be custom-designed to meet the needs of the individual company. As a result each maintenance organization reflects company policy, types of equipment, size of company, whether the company is engaged in deep or strip mining or both, and the general concept and basic philosophy of management. A good maintenance organization also will display the best in management practices, engineering judgment and common sense, plus proper distribution of responsibilities and authority.

Responsibility and authority, in a sense, are one and the same. Certainly a person or department should not be burdened with responsibility without having the authority to follow through. Whether or not any one function of a maintenance department is more important than another is secondary. What is important is that each function for which the maintenance department is responsible should be carried out in a businesslike manner and the cost kept within the budget, regardless of its priority.

The functions for which the maintenance department will be responsible should be established in the initial planning and organizing stage or, in existing organizations, the functions should be re-evaluated periodically.

The "major functions" listed at the beginning of this article provide a basis for developing a maintenance organization. The list can be altered to meet the needs of the individual companies.

Authority

Once the responsibilities have been established, delegating authority logically follows as the next step in organizing. Authority, which goes hand-in-hand with responsibility, should be based on analysis of the job to be done. It also should be defined and contain little or no overlap if confusion and buckpassing are to be avoided.

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Equipment register . . . Historical-data record system . . . Parts-failure report . . . Production and delay reports . . . Inspection reports . . . Weekly and monthly delay summaries . . . Cost records . . . Filing

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Field Reports

Preventive Maintenance: Records Make the Difference—Report and record system is a prerequisite for a follow-through approach to maintenance practices and procedures. *Coal Age,* May, 1960, p 102.

Gorgas Builds for the Future—Regular rebuilding of all major equipment plus unit assembly replacement are two ways to keep production delays to a minimum. *Coal Age,* March, 1960, p 76.

Better Motor Maintenance and Field Testing—How to properly use standard information and nameplate data to achieve an effective motor-maintenance program. *Coal Age,* March, 1960, p 96.

Tips on Belt Conveyor Maintenance—Covers all phases of a belt-conveyor maintenance program and includes a check list for each phase. *Coal Age,* March, 1960, p 100.

Cost Control for Equipment Maintenance—A guide to a new system for controlling cost of equipment maintenance. *Coal Age,* February, 1960, p 118.

Putting Preventive Maintenance to Work—Company personnel designed and set up their own maintenance program complete with record and report forms. *Coal Age,* January, 1960, p 104.

AC Cables for Coal—Survey of types and applications of cables for AC service deals with installation, use and maintenance. *Coal Age,* December, 1959, p 128.

AC Cables for Coal—Comprehensive survey of all cables for AC application in coal mining features complete reference tables on cable types, constructions, capacities and resistance. *Coal Age,* November, 1959, p 104.

Preventive Maintenance: A Positive Approach—How a company reorganized its maintenance system, starting with basic groundwork, into a complete unit-assembly changeout program. *Coal Age,* November, 1959, p 84.

Better Cable Protection with Circuit Interrupters—Individual cable monitors for section equipment protect trailing cables against short circuits and grounds. *Coal Age,* November, 1959, p 91.

A Preventive-Maintenance Program for Your Diesel Engines—A full-scale roundup of preventive maintenance measures for diesel engines. *Coal Age,* October, 1959, p 90.

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How Central-Shop Facilities and Services Pay Off—Points out the numerous cost-cutting opportunities existing through the facilities and services made available by a central shop. *Coal Age,* May, 1959, p 105.

How to Control Cable Cost—A step-by-step description of how to splice and repair cables. *Coal Age,* April, 1959, p 90.

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The desirable chain-of-command policy today is to provide a common or neutral reporting medium for production and maintenance department heads. The general manager or an executive of equal status, for example, has proved the more appropriate.

In the upper echelon of the organization the maintenance superintendent, assistant maintenance superintendent, chief electrician, equipment inspector and special engineers or supervisors have their specific place in the organizational setup, each position with its necessary degree of authority.

It also is necessary to establish lines of authority between first-, second- and third-shift maintenance foremen. There are two avenues of approach: (1) give the first-shift foreman control over the second- and third-shift, or (2) delegate equal authority to each shift foreman, thus placing them on the same level in the organization.

Title assignment is one area of maintenance structure where management needs applied common sense. Each supervisor should be given an appropriate title—one that matches his responsibilities and authority and one that "flavors" his position with respect and prestige.

Personnel

Establish a system of personnel selection aimed at obtaining and qualifying good men.

Design a training program to meet the needs of the company. The goal of such program should be to improve the ability and efficiency of the men by giving them down-to-earth courses that will apply to their daily work routine.

THERE IS NO PLACE in a maintenance organization for men who are not electrically and mechanically inclined, who do not have the interest of the company at heart and who do not have the ability to serve as maintenance foremen or the potentiality to become such. If a maintenance organization is free of men who do not measure up to these standards it will be successful.

Selection

The best assurance a company can have against hiring unqualified supervisors or workers is to establish a system of personnel selection aimed at obtaining and qualifying good men. It does not have to be elaborate and expensive. Even in its simplest form it can serve to determine whether a man is certified or, better yet, qualified to perform the duties that will be expected of him.

It is only good common sense to select men with the ability to do a job rather than to hire somebody just because you need another man. The risk in selecting supervisors, who actually control your profits, requires more than the catch-as-catch-can method. The day of selecting maintenance personnel on the basis of friendship, favoritism and nepotism has passed. Good selections mean lower turnover costs, better employee morale, better production and lower costs of training.

Good selection must be followed by good training.

Training

A training program must be designed to meet the needs of the company. The goals of such programs should be to improve the ability and efficiency of the men by giving them down-to-earth courses that will apply to their daily work routine. Many programs have failed because they were designed to teach theory alone rather than actual needs plus small doses of theory. However, it is important to expose men to basic theory if they are to learn the how and why of things.

Before a training program can be set up it is necessary to consider some of the problems that are likely to be encountered.

1. Will the program be sponsored by the company alone or in conjunction with a vocational school?
2. Who will attend the program?
3. What are the training needs?
4. What methods and techniques will be used?
5. Where will the training take place?
6. How will the courses be scheduled?
7. How large a group will be permitted to attend the courses?
8. Who will teach the course?

While the course of study for electricians and mechanics is pretty well determined by the work they perform—electricity, hydraulics and mechanics—the supervisor's training program is quite different. The supervisor deals mostly with people, not necessarily things, and also with personalities, not always technical know-how. There are a number of courses that can improve maintenance supervision and also prepare supervisors for possible advancements. The courses should include, among other subjects, the following:

1. Organization training.
2. Employment policy and procedure.
3. Maintenance policy and procedure.
4. Contract interpretation.
5. Report writing.
6. Communication policy.
7. Public speaking.
8. Human relations.

Before a training program can be successful it must have the full support of the operating department as well as the maintenance group. Anything short of complete support will result in failure of the training program.

Procedure

Decide on the governing principles, plan a course of action to be followed. This includes provisions for accomplishing all the responsibilities of the department as well as how, when and where these responsibilities will be fulfilled.

Set up plans, schedules and work forces to carry out the policies of the department.

POLICY is the governing principle, plan or course of action followed by the maintenance department to achieve a sound and effective program. Practice is that part of the program designed to carry out the policy. Both policy and practice, however, are controlled, in part, by the operating department and should have the approval of the department heads before any procedure is adopted. At this point it is essential that both the operating and maintenance departments confer with the top echelon of management for final approval.

Policy

Essentially, the maintenance policy must include provisions for accomplishing all the responsibilities assigned the maintenance department.

All work activity of the department can be divided into five classifications:

1. Preventive maintenance.
2. Repair.
3. Overhaul.
4. Construction.
5. Salvage.

These five work-activity classifications can be further refined and broken down into three categories:

1. Predictable Work — Preventive maintenance.

2. Unpredictable Work — Emergency repairs and troubleshooting.

3. Optional Work — Overhaul, construction and salvage.

Once the maintenance program has been broken down into its simplest form, definite policies can be established to assure effective maintenance procedures. Preventive maintenance, for example, requires that equipment be inspected at regular intervals, that routine repairs be made frequently and that equipment be properly lubricated. These requirements, along with many others, are adopted by the maintenance department. Moreover, policy designates how, when and where the requirements will be fulfilled.

Practices

Essentially, the goal in maintenance practices is to see that plans, schedules and work forces are sufficient to carry out the policies of the department.

Of the three categories previously listed preventive maintenance offers the best means for achieving the greatest savings in maintenance costs. The paramount factors contributing to a successful preventive maintenance program are:

1. Selection of scheduled work.
2. Frequency of performing scheduled work.
3. Sufficient work force to complete scheduled work.

Emergency breakdowns or the unpredictable work cannot be controlled. Therefore, it is essential to provide sufficient troubleshooters to handle breakdowns, even if several breakdowns occur at the same time on one or more sections.

Overhaul, construction and salvage work can be contracted or performed by a work force maintained by the company. The problem is to determine whether or not it pays to contract the work or to maintain a working force to do it yourself.

Planning and Scheduling

Use the industrial engineering department to help establish standards. Planning and scheduling of equipment overhauls, minor repairs and routine maintenance are essential.

Make sure that equipment is overhauled as necessary. Standards may have to be altered at times to overhaul certain equipment ahead of its regular scheduled period.

Elect to have major repairs contracted for only after weighing all factors concerned.

WITH A WELL-ORGANIZED and sufficiently staffed maintenance force, prompt and effective maintenance can be accomplished. This also includes planning and scheduling of complete equipment overhauls, minor repairs and routine maintenance jobs, such as, inspecting and lubricating equipment at definite intervals.

Standards

Although industrial engineering has not yet been applied to maintenance in the mining industry to any degree, it does show promise of providing management with another tool to increase the effectiveness of maintenance and to reduce maintenance costs. Equipment and production techniques of today will influence the maintenance techniques of the future—and industrial engineering will play a major role.

Industrial engineering can serve maintenance organizations in a number of ways. These include, among others:

1. Simplification of work.
2. Improvement of shop layout and facilities.
3. Establishment of standard times for specific jobs.
4. Elimination of unnecessary job functions.
5. Increasing the effectiveness of planning and scheduling of all maintenance work.

On-the-Job Maintenance

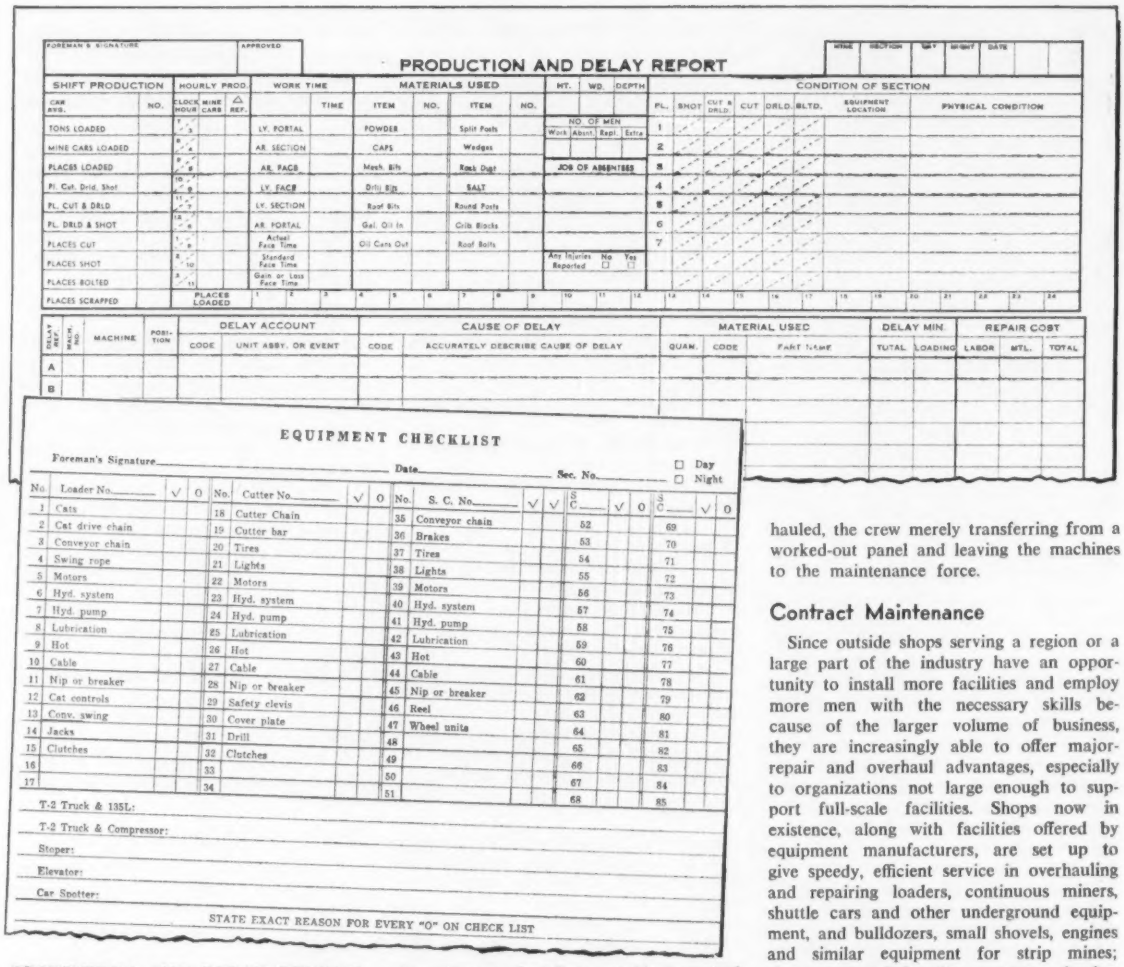
The logical approach to on-the-job maintenance is to consider the necessary types of work to be performed. This leads to the "three-echelon" system, which breaks down as follows:

FIRST ECHELON—Inspection and minor running repairs at the face or in the pit make up first-echelon work. Normally, inspection is conducted by the section or pit electrician and mechanic, along with the operators, and the same men handle running repairs and adjustments.

Whatever the type of operation the basic principle is assignment of sufficient specialists to a unit or a group of units to keep break-downs to a reasonable minimum, since overmanning, in maintenance as in other activities, runs up the cost in excess of the benefits in additional lost-time reduction. Economical maintenance requires proper manpower.

SECOND ECHELON—Major inspections involving some opening of cases and enclosures, and also major repairs or replacement jobs done during idle periods make up second-echelon maintenance. Part of this work, such as, inspection and replacement of certain units and assemblies, may be done at regular intervals, and part will be done when necessary to avoid a potential breakdown or take care of an actual one.

THIRD ECHELON — Normally, third-echelon work involves complete overhaul of a machine on the basis of time, tonnage,



FOREMAN'S SIGNATURE | APPROVED

PRODUCTION AND DELAY REPORT

MINE | SECTION | DAY | SHIFT | DATE

SHIFT PRODUCTION | HOURLY PROD. | WORK TIME | MATERIALS USED | CONDITION OF SECTION

CAR SYS.	NO.	CLOCK HOUR	MINE CARS	△ REF.		TIME	ITEM	NO.	ITEM	NO.
TONS LOADED		1			LV. PORTAL		POWDER		Split Posts	
MINE CARS LOADED		2			AR. SECTION		CAPS		Wedges	
PLACES LOADED		3			AR. FACE		Mach. Bits		Rock Dust	
PL. Cut. Drld. Shot		10			LV. FACE		Drill Bits		SALT	
PL. CUT & DRLD		11			LV. SECTION		Roof Bits		Round Posts	
PL. DRLD & SHOT		12			AR. PORTAL		Gal. Oil In		Crib Blocks	
PLACES CUT		7			Actual Face Time		Oil Cans Out		Roof Bolts	
PLACES SHOT		8			Standard Face Time					
PLACES BOLTED		9			Gain or Loss Face Time					
PLACES SCRAPPED		PLACES LOADED								

WT.	WD.	DEPTH

NO. OF MEN: Work | Absnt. | Rept. | Extra

JOB OF ABSENTEES

Any Injuries Reported: No ☐ Yes ☐

PL.	SHOT	CUT & DRLD	CUT	DRLD.	BLTD.	EQUIPMENT LOCATION	PHYSICAL CONDITION
1							
2							
3							
4							
5							
6							
7							

DELAY REF.	MACH. NO.	MACHINE	POSITION	DELAY ACCOUNT: CODE	DELAY ACCOUNT: UNIT ASSY. OR EVENT	CAUSE OF DELAY: CODE	CAUSE OF DELAY: ACCURATELY DESCRIBE CAUSE OF DELAY	MATERIAL USED: QUAN.	MATERIAL USED: CODE	MATERIAL USED: PART NAME	DELAY MIN.: TOTAL	DELAY MIN.: LOADING	REPAIR COST: LABOR	REPAIR COST: MTL.	REPAIR COST: TOTAL
A															
B															

EQUIPMENT CHECKLIST

Foreman's Signature_____ Date_____ Sec. No._____ ☐ Day ☐ Night

No.	Loader No._____	√	O	No.	Cutter No._____	√	O	No.	S. C. No._____	√	√	No.	√	O	No.	√	O
1	Cats			18	Cutter Chain			35	Conveyor chain			52			69		
2	Cat drive chain			19	Cutter bar			36	Brakes			53			70		
3	Conveyor chain			20	Tires			37	Tires			54			71		
4	Swing rope			21	Lights			38	Lights			55			72		
5	Motors			22	Motors			39	Motors			56			73		
6	Hyd. system			23	Hyd. system			40	Hyd. system			57			74		
7	Hyd. pump			24	Hyd. pump			41	Hyd. pump			58			75		
8	Lubrication			25	Lubrication			42	Lubrication			59			76		
9	Hot			26	Hot			43	Hot			60			77		
10	Cable			27	Cable			44	Cable			61			78		
11	Nip or breaker			28	Nip or breaker			45	Nip or breaker			62			79		
12	Cat controls			29	Safety clevis			46	Reel			63			80		
13	Conv. swing			30	Cover plate			47	Wheel units			64			81		
14	Jacks			31	Drill			48				65			82		
15	Clutches			32	Clutches			49				66			83		
16				33				50				67			84		
17				34				51				68			85		

T-2 Truck & 135L:

T-2 Truck & Compressor:

Stoper:

Elevator:

Car Spotter:

STATE EXACT REASON FOR EVERY "O" ON CHECK LIST

PRODUCTION AND DELAY REPORTS, and equipment checklists, provide perpetual performance records for equipment. Reports above are filled out by section foremen.

yardage or hours worked. Underground units and small stripping units, as examples, normally are brought to the shop, or sent to an outside custom shop, for complete dismantling and rebuilding, and large stripping units are moved back from the face or out of the pit to prepared overhaul areas.

Aside from equipment, third-echelon work takes in such other activities as the repair of conveyor belts, large truck tires and similar items, for which some companies have special shops or shop sections. Others use custom shops or manufacturers' repair and service facilities.

Overhaul Scheduling

Five of the standards for determining when overhauling is necessary are:

1. **Elapsed time**—in weeks or months. In other words, machines are taken out of service at specific intervals for overhaul.
2. **Operating time** in hours or days.
3. **Tonnage or yardage handled.**
4. **Inspection.**
5. **Personal judgment.**

Each of these standards has its supporters among maintenance and operating men, though more of them seem to operate on the basis of a combination of inspection and hours operated or tonnage or yardage handled. Where the number of units is large, on the other hand, supporters of the elapsed-time standard point out that a rigid schedule is necessary to permit getting around to all the machines without jams resulting from two or three coming up for overhaul.

A sixth system is, in effect, no overhaul —or overhaul only at long intervals. Under this system, known as unit replacement, overhaul is accomplished by replacing assemblies, such as rear conveyors on loaders, crawlers on shovels and the like, removing the replaced assemblies to the shop for overhaul and storage until another assembly on another machine comes up for replacement.

What might be called a seventh system is practiced at at least one mine where the coal is low, belts are employed, and the difficulty of handling a major breakdown is much greater than in thicker coal. At this operation, each new panel is started with equipment that has been completely overhauled, the crew merely transferring from a worked-out panel and leaving the machines to the maintenance force.

Contract Maintenance

Since outside shops serving a region or a large part of the industry have an opportunity to install more facilities and employ more men with the necessary skills because of the larger volume of business, they are increasingly able to offer major-repair and overhaul advantages, especially to organizations not large enough to support full-scale facilities. Shops now in existence, along with facilities offered by equipment manufacturers, are set up to give speedy, efficient service in overhauling and repairing loaders, continuous miners, shuttle cars and other underground equipment, and bulldozers, small shovels, engines and similar equipment for strip mines; plus conveyor belts, tires, motors and other components. Bit sharpening, drill sharpening and other service shops round out the list.

Reports and Records

Make certain that reports and records provide necessary information on the cause of delays and time lost.

Concentrate where the greatest gains can be made by using information received from detailed reports.

Have equipment inspected in detail at regular intervals.

Keep cost records of repair parts and labor for each unit.

Route summaries of reports and records weekly or monthly to responsible operating and maintenance heads.

CONTROL OF THE TOTAL COST OF COAL PRODUCTION is contingent to a marked degree upon effective control of equipment maintenance. Maintenance progress is difficult without proper reports and records. Even though paper work is involved, careful study of the types and number of forms will reduce it to a minimum —and will make that minimum more valuable.

The objective of a maintenance cost-control program is primarily to provide adequate detail to permit pinpointing specific parts for study. This program also should permit follow-up to determine if remedial action is effective and, in addition, should provide information for determining comparative merits of equipment from different manufacturers. Further, it should provide adequate information on which to base decisions with respect to retiring equipment nearing the end of its economic maintenance life. A long-range objective should be to provide a method of determining labor performance on maintenance.

Equipment Register

Maintenance records are tailored to the class of equipment. These records (see illustrated repairs and maintenance equipment register) show budgeted repairs and maintenance cost, actual cost, and variance for the month and quarterly year-to-date totals.

Control data are recorded on visible-edge cards which are filed in book units. Separate cards are maintained for each class of equipment for each mine. Units of production or net tons of coal handled by the respective classes of equipment are recorded. Maintenance costs are detailed as to labor and material, and the budgeted as well as actual costs and variances are shown.

A colored signal along the edge of each card indicates percentage variance for the year-to-date, favorable or unfavorable.

Historical-Data Record System

Specific historical data are recorded on two general types of cards which, normally, are filed in the maintenance superintendent's office. The assemblies exchanged or repaired card (see illustration) is an example of the master or accumulator record. The headings on this card vary with the type of equipment. Across the top are headings for data and name of assemblies or components classified as to major categories, such as, electrical, hydraulic, traction, conveyor, spray, etc., as well as equipment-delay hours and maintenance man-hours. A separate card is provided for each major equipment item.

A parts-used card accompanies the historical data record. This card provides space for date, equipment classification and number and, by symbol, whether the work was performed by the sectional repairman, surface shop crew or the roving repair crew.

Parts used are detailed by catalog number and description. Delay time and maintenance hours involved also are recorded. Small hardware, such as, bolts, cap screws, lock washers, etc., are not recorded.

Parts-Failure Report

Another possible service obtainable from records is a report that will pinpoint areas of repetitive equipment failure. It is divided into two sections and is prepared on a monthly basis. One section summarizes by assembly the cost per 100 equipment operating hours of regular maintenance, detailed by labor, critical parts used and delay costs, and cost of equipment overhaul, detailed by labor and critical parts used.

The other section of the report involves specific parts used. The initial detail is on a selective basis when the cost per 100 equipment operating hours for an individual piece of equipment exceeds a predetermined amount set by engineering studies.

Production and Delay Reports

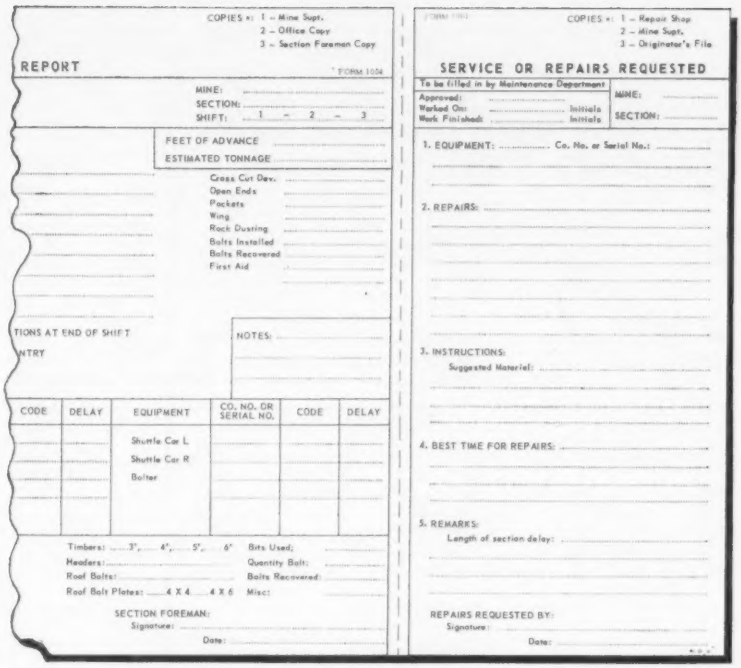
To simplify the various forms and to reduce writing a delay-account code for mine and preparation equipment should be established. The mine code should provide numbers for all delay sources. The preparation-plant code should provide numbers for each equipment item.

The daily delay or operating report is a must. It shows what the mechanical and electrical failures were and how much time was lost with each. Also, these reports may be expanded to show other delays and their causes to permit appropriate action. Thus, they become running time studies of machine performance, and provide invaluable data for eliminating the causes of reduced efficiency.

This report may be rather simple and concentrate on production and delays only. Or, it may include details on labor, parts used and a description of work done. For example, a delay report may provide space for recording such information as:

Machine Data—Number, type and position.

Delay Account—Code, unit-assembly or event.



COPIES x: 1 – Mine Supt. 2 – Office Copy 3 – Section Foreman Copy

REPORT

MINE:
SECTION:
SHIFT: 1 – 2 – 3

FEET OF ADVANCE
ESTIMATED TONNAGE

Cross Cut Dev.
Open Ends
Pockets
Wing
Rock Dusting
Bolts Installed
Bolts Recovered
First Aid

TIONS AT END OF SHIFT
NTRY

NOTES:

CODE	DELAY	EQUIPMENT	CO. NO. OR SERIAL NO.	CODE	DELAY
		Shuttle Car L			
		Shuttle Car R			
		Bolter			

Timbers: 3", 4", 5", 6" Bits Used:
Headers: Quantity Bolt:
Roof Bolts: Bolts Recovered:
Roof Bolt Plates: 4 X 4 4 X 6 Misc:

SECTION FOREMAN:
Signature:
Date:

COPIES x: 1 – Repair Shop 2 – Mine Supt. 3 – Originator's File

SERVICE OR REPAIRS REQUESTED

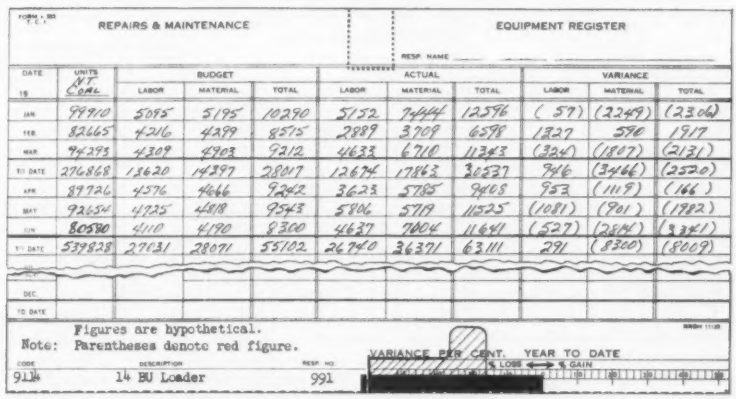
To be filled in by Maintenance Department
Approved:
Worked On: Initials
Work Finished: Initials

MINE:
SECTION:

1. EQUIPMENT: Co. No. or Serial No.:
2. REPAIRS:
3. INSTRUCTIONS:
Suggested Material:
4. BEST TIME FOR REPAIRS:
5. REMARKS:
Length of section delay:

REPAIRS REQUESTED BY:
Signature:
Date:

SERVICE OR REPAIRS-REQUESTED FORM provides for listing equipment that needs service, nature of disability, situation under which trouble occurred and other necessary information. It is attached to the foreman's daily report.



REPAIRS & MAINTENANCE — EQUIPMENT REGISTER

RESP. NAME

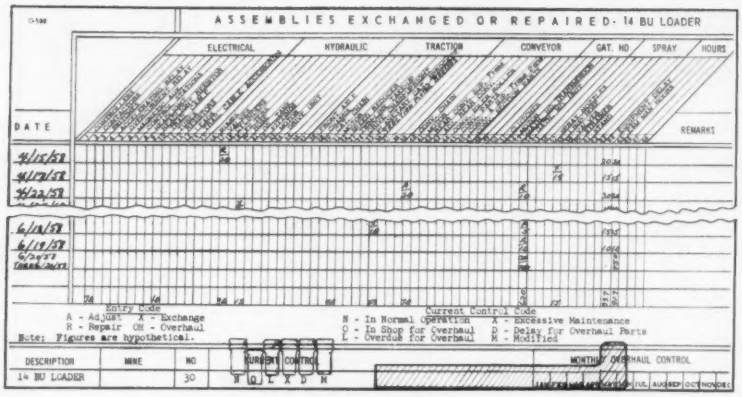
DATE 19	UNITS NT. COAL	BUDGET LABOR	BUDGET MATERIAL	BUDGET TOTAL	ACTUAL LABOR	ACTUAL MATERIAL	ACTUAL TOTAL	VARIANCE LABOR	VARIANCE MATERIAL	VARIANCE TOTAL
JAN	99910	5095	5195	10290	5152	7444	12596	(57)	(2249)	(2306)
FEB	82665	4216	4299	8515	2889	3709	6598	1327	590	1917
MAR	94293	4309	4903	9212	4633	6710	11343	(324)	(1807)	(2131)
1st DATE	276868	13620	14397	28017	12674	17863	30537	946	(3466)	(2520)
APR	89726	4576	4666	9242	3623	5785	9408	953	(1119)	(166)
MAY	92654	4725	4818	9543	5806	5719	11525	(1081)	(901)	(1982)
JUN	80580	4110	4190	8300	4637	7004	11641	(527)	(2814)	(3341)
1st DATE	539828	27031	28071	55102	26740	36371	63111	291	(8300)	(8009)
JUL										
DEC.										
TO DATE										

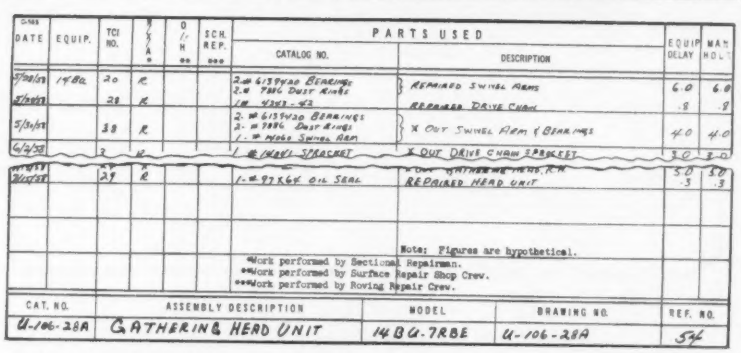
Figures are hypothetical.
Note: Parentheses denote red figure.

VARIANCE PER CENT. YEAR TO DATE
% LOSS ⟷ % GAIN

CODE 9114 DESCRIPTION 14 BU Loader RESP. NO. 991

REPAIRS AND MAINTENANCE EQUIPMENT REGISTER will show whether material usage and labor costs for the loader exceeded or was under the budget allowance.



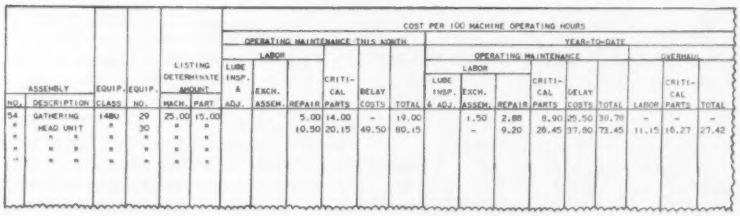


ASSEMBLIES EXCHANGED OR REPAIRED CARD AND PARTS-USED CARD provide a historical-data record system. Reports and records are kept in the maintenance superintendent's office.

MONTH OF JUNE, 1958

CRITICAL PARTS (LISTED ON EXCEPTION BASIS)

PART NO.	DESCRIPTION	QUANTITY THIS MONTH REGULAR MAINT.	QUANTITY THIS MONTH OVER-HAUL	QUANTITY YEAR-TO-DATE REGULAR MAINT.	QUANTITY YEAR-TO-DATE OVER-HAUL	QUANTITY YEAR-TO-DATE TOTAL	QUANTITY PER 1000 EQUIPMENT OPERATING HOURS THIS MONTH	QUANTITY PER 1000 EQUIPMENT OPERATING HOURS YR. TO DATE	COST PER 1000 EQUIPMENT OPERATING HOURS THIS MONTH	COST PER 1000 EQUIPMENT OPERATING HOURS YR. TO DATE
14041	SPROCKET	1		1		1	3.33	.96	112.07	32.31
4343-1	DRIVE CHAIN LINK	1		4		4	3.33	3.33	2.57	2.57
4343-42	DRIVE CHAIN	1		1		1	3.33	.96	86.81	25.02
6139420	BEARING		4	3	4	7	13.33	5.83	182.55	79.84
7886	DUST RING		4	3	4	7	13.33	5.83	4.67	2.04
14060	SWIVEL ARM		1	2	1	3	3.33	2.50	342.08	256.62



REPORT OF SELECTED REPETITIVE MAINTENANCE COSTS by equipment assembly and part number is designed to pinpoint areas of repetitive equipment failure. Report is in two sections.

Cause of Delay—Code, reason for delay.

Material Used—Quantity, code and part number.

Delay Time—Total downtime and loading time lost.

Repair Cost—Labor and material.

Equipment Checklist

This form, filled out by section and plant foremen, lists the code numbers and equipment items. Space is provided at the right or left of each equipment item to indicate whether it is in good condition or whether it needs attention. Space also is provided to permit foremen to explain why equipment needs repair.

Work-Needed Report

To attain fully the goal of preventing breakdowns, some form of reporting on work or adjustments needed is a necessity. It permits reporting a part that seems likely to fail so that the necessary steps may be taken to repair or replace it on the next idle shift.

Work needed may be reported either on the front or back of the regular delay form, or it may be reported on a special form. Where it is entered on a special form, special handling may be necessary to make sure that both the repair foreman and the superintendent, for example, get the data they need without delay. Or, the forms may be made out in duplicate or triplicate and routed accordingly.

Where separate forms are used, the original naturally goes to the repair foreman, with perhaps a copy to the superintendent. In some instances, the form includes space for reporting on when the work needed was done, with or without copy to the superintendent, as a further means of insuring that prompt action is taken.

Inspection Report

As a second means of preventing breakdowns, a number of mining operations have instituted inspection reports. The frequency of such reports can vary from daily to monthly or longer, with a week or a month the most common. The reports are derived from special inspections of a varying degree of thoroughness, and normally involve going into certain cases and the like. In other words, the machine is given a more thorough examination than would normally be involved in a quick daily once-over.

Inspections may be made by the regular section electricians or mechanics, or by special men from the mine or central shop. These men at the same time can make certain adjustments and repairs, and can note larger jobs that may require taking the unit out of service.

A recent newcomer to mine maintenance personnel is the electrical-mechanical inspector. His primary duties are to conduct and plan inspection schedules for all equipment, make out equipment reports and submit them to responsible operating and maintenance heads, to make sure that work orders are carried out and completed as scheduled, and to recommend when certain equipment should be taken out of service for overhaul.

FIVE- AND FIFTEEN-DAY PRODUCTION MAINTENANCE REPORTS — These basic inspection reports permit detection of trouble prior to breakdowns. They are issued regularly by the maintenance supervisor and must be returned promptly by repairmen conducting maintenance on idle shifts. The items listed (see report form) are intended to cover most areas of possible equipment trouble. The inspector must indicate that action has been taken on all items, either listing his **OK** or noting that he has initiated corrective action. The maintenance supervisor, after receiving the form at the end of the inspection period, conducts frequent follow-up checks to determine the quality of the action taken.

The work on the 5- and 15-day reports can be done any time during the designated



5-DAY PRODUCTION MAINTENANCE REPORT

(This report is to be returned to Shop at end of 5-day check showing items inspected or repaired)

Date
Mine
Section

JOY LOADER

( ) ( ) ( ) ( ) ( ) Lubricate
( ) ( ) ( ) ( ) ( ) Conveyor Chain: flights, rivets, keys, straps, nuts, and adjustment.
( ) ( ) ( ) ( ) ( ) Drive Chain, wear, adjustments, keys, guards, and oil.
( ) ( ) ( ) ( ) ( ) Speed reducer oil level.
( ) Arm Bearing Adjustments
( ) Conveyor Assembly: foot shaft, idler roller, guides, and swing ropes.
( ) Hydraulic System: hoses, fittings, jacks, jack-pins and leaks.
( ) Physical body—bumper, guards, contactor cover, external cables, etc.

JOY SHUTTLE CARS

( ) 1st Car (Left Hand)
( ) ( ) ( ) ( ) ( ) Lubricate.
(–) (–) (–) (–) (–) Lubricate.
( ) ( ) ( ) ( ) ( ) Oil level, speed reducers.
(–) (–) (–) (–) (–) Oil level, speed reducers.
( ) ( ) ( ) ( ) ( ) Wheel units, lug bolts, Universal bolts, and tire pressure (visual).
(–) (–) (–) (–) (–) Wheel units, lug bolts, Universal bolts, and tire pressure (visual).
(–) 2nd Car (Right Hand)
( ) (–) Conveyor: flights, chain, keys, straps.
( ) (–) Spooling devices: spools, thread bar, and sheaves.
( ) (–) Conveyor Clutch—mechanical linkage.
( ) (–) Headlights.
( ) (–) Hydraulic System: hoses, fittings, and leaks.
( ) (–) Brakes: fluid and lining.
( ) (–) Physical Body: reel box, guards, sheave bracket bolt, external cables, etc.

JOY CUTTING MACHINE

( ) ( ) ( ) ( ) ( ) Lubricate
( ) Cutter Bar, cutter bar chain, and dead lugs.
( ) Controller, fingers, arc-divider reverse.
( ) Guards and rope on cylinders.

JOY T-2 TRUCKS

( ) ( ) ( ) ( ) ( ) Oil level: speed reducers.
( ) ( ) ( ) ( ) ( ) Drive Chains: wear, adjustment, keys, guards, and oil.
( ) ( ) ( ) ( ) ( ) Spooling Devices: spool, threadbar, and guards.

CAR HOIST

( ) Lubricate.
( ) Clutch and gears.
( ) Guards and rope.

JOY DRILLS

( ) Lubricate.
( ) Hoses – fittings, and leaks.

JOY CONTINUOUS MINER

( ) ( ) ( ) ( ) ( ) Lubrication (daily)
( ) ( ) ( ) ( ) ( ) Water system sprays, hoses, valve, etc. (daily).
( ) ( ) ( ) ( ) ( ) Bits (daily)
( ) ( ) ( ) ( ) ( ) Timber Jacks.
( ) ( ) ( ) ( ) ( ) Conveyor chains, pins, locks, straps, etc. (daily)
( ) ( ) ( ) ( ) ( ) Boring Arms (daily)
( ) Gear cases.
( ) Hydraulic hoses.
( ) Head light – Bulb, wiring, etc.
( ) Chassis & turntable.
( ) Hopper
( ) Dust guards.
( ) Ripper chain – adjustment.
( ) Belts, pump end, front conveyor, cleanup drive, etc.
( ) Trim chain – upper
( ) Trim chain – lower
( ) Lubrication pump
( ) Roof Bolter, drive sockets

Notes and Suggestions

Parts Used and Probable Cause of Failure

Parts Needed

Repairman



15-DAY PRODUCTION MAINTENANCE REPORT

(This report is to be returned at the end of 15 days. Check only after item is inspected or repaired.)

Date
Mine
Section

JOY LOADER

( ) Motors: brushes, fields, commutator, wiring.
( ) Control Panel: main contact tips, fuses, mercury tubes, wiring.
( ) Controls: fingerboard, contacts, segments wiring.
( ) Reducers: oil level, adjustments.
( ) Car Chains: pin checks, wear, inspection, adjustments.
( ) Clutch Settings: rated amperage
( ) Pivot Pins & Hinge Points
( ) All leads, glands & junction points
( ) Cable

JOY SHUTTLE CARS

( ) 1st Car (Left Hand)
( ) (–) Motors & brushes, fields, commutator, wiring.
( ) (–) Control Panel: main contact tips, fuses, mercury tubes, wiring.
( ) (–) Controls: fingerboard, contacts, segments, wiring.
(–) 2nd Car (Right Hand)
( ) (–) Reducers: oil level adjustments.
( ) (–) Clutch Setting: adjustments.
( ) (–) Boom: pivot points sideboards
( ) (–) Steering adjustments, if needed.
( ) (–) Cable

JOY T-2 TRUCKS

( ) Motors, brushes, fields, commutators, wiring.
( ) Resistors: wiring, grid conditions.
( ) Armature Bearings
( ) Contactor: fingers, drums, wiring, blowout coil, arc divider.

JOY CUTTING MACHINES

( ) Motors, brushes, fields, commutators, wiring.
( ) Control Panel: main control tips, fuses, mercury tubes, wiring resistors.
( ) Controls: fingerboard contacts, segments, wiring.
( ) Reducers: oil level, adjustment.
( ) Cables

CAR HOIST

( ) Motor: brushes, fields, commutator, and wiring.
( ) Resistor.

JOY DRILLS

( ) Motor: brushes, fields, commutator.
( ) Hydraulic pressure and amperage setting.
( ) Mechanical body.

Notes

Parts Used and Probable Cause of Failure

Parts Needed

Repairman

FIVE- AND FIFTEEN-DAY INSPECTION REPORTS detect trouble before breakdowns occur and also provide record of inspections of vital components.

period, except on items which need daily attention.

Each equipment item is listed on the report so that it will be checked at the proper time interval. The 5- and 15-day periods are suggested for routine operations. The maintenance supervisor may choose time periods more suitable.

Weekly and Monthly Delay Summaries

These reports provide a periodic summary of the progress and effectiveness of the preventive maintenance program. Weekly reports give a quick breakdown of the amount of delays by section (day and night shifts) and the frequency for each delay source. Total delays in minutes, percentage of work time lost and the amount of tonnage lost complete the standard weekly summary report.

The monthly delay summary is a more comprehensive report than the weekly. It gives a broader view of the over-all program and enables supervisors to spot weak or trouble areas in the maintenance structure. Information contained in the monthly summary is obtained from the weekly reports.

Cost Records

There is a growing trend toward keeping a complete record of repair parts and labor unit by unit. Labor in this instance normally means special labor beyond the usual attention given by the section mechanic—in other words, shop and special labor required for major repairs and overhauls. Paper work is increased but the accurate unit record provides, among others, these advantages.

1. Excessive expenditures may signal waste or loss of parts sent into the section for running repairs, as well as lack of lubrication, abuse of the machine by operators, and so on.

2. Rising expenditures may signal the need for overhaul earlier than normally scheduled to prevent excessive machine breakdowns.

3. Consistently higher expenditures for one type of machine, compared to another of equal capacity, may make it desirable to standardize on the lower-maintenance unit, other things being equal.

4. Data on the value of special materials—for example, stainless steel—can be readily obtained to show if they are worthwhile or not.

For maximum convenience, unit cost records may be kept on cards designed for rotary or other quick-viewing files. The data for the records naturally comes from requisitions for parts and materials submitted by the foremen or other responsible officials, and from reports on parts used and labor expended by the repair foreman. Naturally, also, summaries of the unit records should be made at regular intervals—perhaps monthly—for the superintendent and other officials having jurisdiction.

Filing

The type of report will, in many instances, indicate who should file it—for example, a report on work completed by the repair foreman, or on lubrication by the head of the lubricating crew, if one is employed. Daily delay and operating reports may be filed by the foreman or the operator of the key machine, with some arguing for the machine operator since the foreman may not be with the machine at all times. Operator reports, if that is the system, naturally should be filed through the foreman, who will check and countersign.

Where several machines make up a unit, there may be a question as to whether reports should be required of the several operators—for example, cutters, shuttle-car drivers, etc. Among other things, such reports might be valuable by focusing operator attention on the need for good maintenance and care in operation. Practically, however, one report, especially if prepared by or with the cooperation of the foreman, usually can provide the necessary information.

Reports on work needed likewise may be filed by the operator, the foreman or the section mechanic, working with each other.

Whatever the number and scope of the various reports, the rule should be a practical system.

Spare Equipment

Provide spare equipment, when practical, to reduce the effects of breakdowns.

Furnish extra equipment to replace units scheduled for overhaul.



FORM 1010
Sheet #1

SUMMARY OF DELAYS

Date .....
Mine .....

SECTIONS	(1)			(2)			(3)			(4)			TOTAL	
TOTAL WORK TIME FOR MONTH (MIN.)														
1. LOADER MECH.	F	MINS.	%	F	MINS.	%	F	MINS.	%	F	MINS.	%	F	MINS
1. Gathering Arms														
2. Lubricate														
3. Conveyor Chain														
4. Tramming Chain														
5. Cat. Chain														
6. Speed Reducer														
7. Hydraulic Hose														
8. Boom Swing Rope														
9. Hydraulic Pump														
10. Hydraulic Control Valve														
11. Idler Sprocket														
12. Jacks														
13.														
14.														
15.														
16.														
TOTAL LOADER MECH.														
LOADER ELEC.														
1. Splices, Trailing Cable														
2. Power														
3. Resistance														
4. Coil														
5. Grounded														
6. Contactors														
7. Pump Motor														
8. Traction Motor														
9.														
10.														
11.														
TOTAL LOADER ELEC.														
2. CONTINUOUS MINER														
1. Set Bits														
2. Water Hose														
3. Spline Shaft														
4. Ripper Chains														
5. Boring Arms														
6. Trim Chain – Top														
7. Trim Chain – Bottom														
8.														
9.														
10.														
TOTAL CONTINUOUS MINER														
3. SHUTTLE CAR MECH.														
1. Lubricate														
2. Conveyor Chain														
3. Conveyor Clutch														
4. Bent Flight														
5. Hydraulic Hose														
6. Hydraulic Pump														
7. Brakes														

F – Denotes Frequency

FORM 1010
Sheet #2

SUMMARY OF DELAYS

SECTIONS	(1)			(2)			(3)		
TOTAL WORK TIME FOR MONTH (MIN.)									
3. SHUTTLE CAR MECH.	F	MINS.	%	F	MINS.	%	F	MINS.	%
8. Master Cylinder									
9. Lug Bolts									
10. Flat Tire									
11. Wheel Unit									
12. Universal Joint									
13. Reel Fouled									
14. Reel Chain									
15. Cable Guide									
16. Drive Shaft									
17. Tie Rods									
18. Thread Bar									
19. Steering Arms									
20.									
21.									
22.									
TOTAL SHUTTLE CAR MECH.									
SHUTTLE CAR ELEC.									
1. Power									
2. Splices, Trailing Cable									
3. Grounded									
4. Coil									
5. Contactors									
6. Traction Motor									
7. Pump Motor									
8. Leads									
9.									
10.									
11.									
TOTAL SHUTTLE CAR ELEC.									
4. CUTTER MECHANICAL									
1. Cutter Bar									
2. Tramming Chain									
3. Feed Rope									
4. Hydraulic Hoses									
5. Steering Jacks									
6. Tires									
7. Sprocket									
8.									
9.									
10.									
TOTAL CUTTER MECHANICAL									
CUTTER ELECTRICAL									
1. Splices Trailing Cable									
2. Grounded									
3. Contactors									
4. Traction Motor									
5. Cutter Motor									
6.									
7.									
8.									
TOTAL CUTTER ELECTRICAL									

F – Denotes Frequency

FORM 1010
Sheet #3

SUMM

SECTIONS	(1)			(2
TOTAL WORK TIME FOR MONTH (MIN.)				
5. COAL DRILL MECH.	F	MINS.	%	F	MINS
1. Hose					
2. Pump					
3.					
4.					
5.					
TOTAL COAL DRILL MECH.					
COAL DRILL ELEC.					
1. Splices, Trailing Cable					
2. Switch					
3. Motor					
4.					
5.					
6.					
TOTAL COAL DRILL ELEC.					
6. ROOF BOLTER MECH.					
1. Drive Mechanism					
2. Tires					
3. Clutch					
4.					
TOTAL ROOF BOLTER MECH.					
ROOF BOLTER ELEC.					
1. Splices, Trailing Cable					
2. Motor					
3. Controller					
4.					
5.					
6.					
TOTAL ROOF BOLTER ELEC.					
7. OTHER DELAYS					
1. Accident on Section					
2. Safety Meeting					
3. Key Operator Absent					
4. Pre-Shift Examination					
5. Engrs. Set Spads					
6. Mantrip Late					
7. Lunch, Men not Floated					
8. No Coal					
9. Ramp					
10. Wrecks					
11. No Empties					
12. Hoist Pulled Out					
13. Hoist Rope Broken					
14. Airdox or Powder					
15. Equipment Conflict					
16. Change Out Machines					
17. Move to New Setup					
18. Scale Top					
19. Timber					
20. Handling Supplies					
21. Roadways					

F – Denotes Frequency

FORM 1010
Sheet #4

SECTIONS
TOTAL WORK TIME FOR MONTH (MIN.)
7. OTHER DELAYS (Cont.)
22. Slate Fall
23. Equipment Stuck
24. Power
25. Shot Failure
26. Smoke
27. Water
28. Move Cable
29. Rock Dust
30.
31.
32.
33.
34.
35.
TOTAL OTHER DELAYS
TOTAL MECH. DELAYS
TOTAL ELEC. DELAYS
GRAND TOTAL DELAYS
NOTES
1. Total Days Operated
2.
3.
4.

F – Denotes Frequency

REMARKS:

SUMMARY OF DELAYS is used to analyze downtime characteristics, total cost and reasons for delays. Records are maintained by the accounting department or a maintenance clerk. These records keep management informed in all phases of maintenance.

Standardize mining equipment as much as possible to reduce maintenance work and cut inventory.

ONE METHOD OF ALLEVIATING effects of major breakdowns is keeping spare units on hand, provided the cost of such spare units can be kept within reasonable limits.

Limitations

On large units it is impracticable to buy, say, two 30-yd shovels, one to substitute for the other when it breaks down.

With smaller units, such as underground loading machines, a much-greater opportunity exists for keeping spares on hand without excessive investment. General practice is to provide a spare for each 3 to 5 major production units, such as, loaders, cutters, continuous miners, shuttle cars, etc.

Basically, the number of spares depends upon conditions and particularly on the extent to which preventive maintenance reduces major breakdowns. Time necessarily is involved in getting the inoperative machine out of the way and the new one in, regardless of how close the spare may be. If breakdown time can be kept below that figure without exception, there theoretically would be no need for spare units, except to maintain output during overhaul periods.

But since breakdowns have an annoying habit of causing lengthy delays, there is an opportunity for the spare units, and that opportunity increases as breakdown frequency and time increases. However, there is a drawback. Investment in equipment—and in parts and labor to take care of breakdowns—also increases. The conclusion is that preventive maintenance on the working units is the real goal, and will reduce the need for spare equipment and also the breakdown cost.

A second factor determining spareunit practice is the overhaul schedule. With intervals of 6 mo to 2 yr on major underground units and on certain surface units, and with overhauls requiring up to a month or more, spares are a necessity if production is to be maintained at a certain level. Usual practice is to take an underground machine out of the section, or a small portable unit out of the strip pit, and send in the spare unit. Certain underground mines, however, follow the practice of keeping extra completely equipped sections, and transferring the crews for the overhaul period, on the basis that moving men is less costly than moving equipment.

Standardization

Standardization of mining equipment, of course, has its limits, and complete standardization would make it difficult to work in new types of machines and thus take advantage of their characteristics. But with fewer types of equipment, including components such as motors and the like, there is a much greater opportunity for learning all about the equipment and how to handle it. Also, repair-part inventories are reduced and the problem of receiving, storing and issuing parts is simplified.

Unit Changeout

The most recent advance in mine maintenance is the unit changeout system. Al-

though this system involves a rather large initial outlay of capital the results after the program gets under way show a substantial decrease in machine downtime and replacement of parts.

The success of this program depends on five major factors:

1. Organizing the program.

2. Evaluating the equipment to determine within safe limits the average life of the various units that are to be changed out periodically.

3. Supplying an adequate number of spare units and replacement parts.

4. Allocating a sufficient number of men to carry out the program, both in the shop for rebuilding the units and inside the mine for changing them out.

5. Keeping an accurate record of each equipment item.

Once the program is in operation, accurate records must be kept to insure its success. Records, for the most part, consist of a master equipment chart. This chart lists all equipment and its location, and provides space for recording information on the units of each machine that are included in the changeout program. The information includes frequency of changeout, when they were changed last and when they are to be changed out again.

Shops

Plan to centralize main-shop work where transportation is to your advantage.

Design shops to match individual operations taking into account such factors as, size of operation, type of equipment, type of work done and other items involved in planning a central shop.

Locate shops at the most economical and convenient places.

Provide facilities so that troubleshooters can get to breakdowns quickly.

Central Shops

Central shops generally are defined as establishments where work beyond the removal and replacement of parts and assemblies is done. It is difficult, however, to be precise as to what main or central shops are, since they vary widely in goals, scope of work handled, and equipment. Normally, however, their main business is major repair and overhaul, and to facilitate this they usually include machine tools and other equipment not found in mine shops. On the other hand, main shops can function as mine shops, and they may also in some instances, include facilities for manufacturing repair parts and even complete equipment units.

Where several mines are operated by a single company, the question arises as to whether to have a main shop at each operation or a big central shop for all. The trend seems to be toward centralizing main-shop work in one plant, especially where good highway and rail connections are available. The advantages include:

1. Less duplication of equipment and facilities, in turn providing an opportunity for adding extra facilities in the main shop without increasing overall expenditure.

2. An opportunity to provide additional repair and maintenance skills because the volume of work is sufficient to warrant employment of certain specialists.

3. An opportunity for increasing efficiency because of the greater volume of work in one place.

4. Less duplication of parts and supply inventories, and consequently a reduction in inventory, as a result of concentration of operations.

SHOP TYPES—Main shops may include types aside from the general overhaul and repair units devoted to machine reconditioning. Examples are: conveyor-belt shops, wheel-reclamation and welding shops, truck-tire shops, mine car shops and so on. Such shops may be separate or may be incorporated into the main shop via separate rooms, bays and the like, and, of course, are warranted only when the volume of specialized work is sufficient to make them practical.

SHOP LAYOUT—Since size of operation, type of equipment, type of work done and other factors vary widely, no prescription can be given for a typical main or central shop. A summary of layout and facilities for three specific shops, however, is as follows:

STRIP-MINE SERVICE CENTER—L-shaped shop, warehouse and garage structure, with 66x215-ft garage as the base of the L; next a 59x32-ft warehouse; and completing the upright of the L, a 59x84-ft machine shop. Thus, the warehouse is conveniently located between the machine shop and the garage. The garage is fitted with 10 rollup doors, and handles the maintenance and repair of all gasoline, butane and diesel equipment and pumps (but not motors), as well as serving as the headquarters for the maintenance of two small walking draglines. Extra engines, and some heavy spare parts, including some rear end transmissions, are kept in a fenced-off enclosure in the garage, which is equipped with a 2-ton hoist on an overhead track.

The warehouse includes a 25x25-ft partitioned section in one corner serving as the electrical shop. Warehouse facilities include convenient outdoor storage for heavy shovel parts while lighter parts that can be brought inside—via a 5-ton chain hoist mounted on overhead rails—are stored on the floor. Bins, of course, are provided for the smaller items.

The machine shop does work for the garage, electrical shop and the field force, and is equipped with three radial drills—one large and two small: horizontal lathe, 20-ft bed, 36-in swing; 12-in lathe, 18-in utility saw, shaper, bolt machine (up to ¾ in), three hand-welding machines, automatically controlled gas-cutting unit, automatic continuous welding machine, two 5-ton and two 2-ton chain hoists.

DEEP-MINE CENTRAL SHOP—Three-building establishment, all connected with doors wide enough and high enough to permit passage of portable cranes, thus avoiding the use of heavy overhead cranes and hoists; windowless Quonset construction, with fluorescent lighting. Unit functions equipment are:

Building 1, 40x100 ft, rebuilding shuttle cars, loaders and continuous miners; steel work benches, two bench drills, vises, two 300-amp portable welders, gas-welding equipment, air-operated impact wrenches and portable drills, test panel for mercury tubes.

Building 2, 40x100 ft, rebuilding rubber-tired cutters, rubber-tired coal drills, roof drills and other mining machinery; wall-type work benches, special floor-type work bench for repairing shuttle-car wheel units, two welding machines, cable vulcanizer, cable-conductor welder, and 150-kw rotary converter for DC test power.

Building 3, double Quonset 60x80 ft plus single Quonset 60x40 ft, building up and machining parts for mines and preparation plants; wheel press; 20-in, 48-in and two 24-in lathes, milling machine, radial drill, 20-in shaper, bolt threader, slotter, metal-cutting band saw, bit cutoff machine, blacksmith forge, air compressor for the three buildings, two degreasers, heating boiler, welding machine, and floor controlled bridge crane across lathe bay; also toilet and shower facilities in 20x20-ft room.

DEEP AND STRIP SHOP—Though designed primarily for the complete rebuilding of underground equipment, one shop also handles certain work for the company's strip operations. Size of the two-story building is 213x95 ft inside, and it includes offices and a supply room. A modified assembly-line procedure is followed, with types of machines assigned to certain bays, and parts removed to service bays for reconditioning before return to the unit. An outside cleaning station is a major contribution to quality and efficiency.

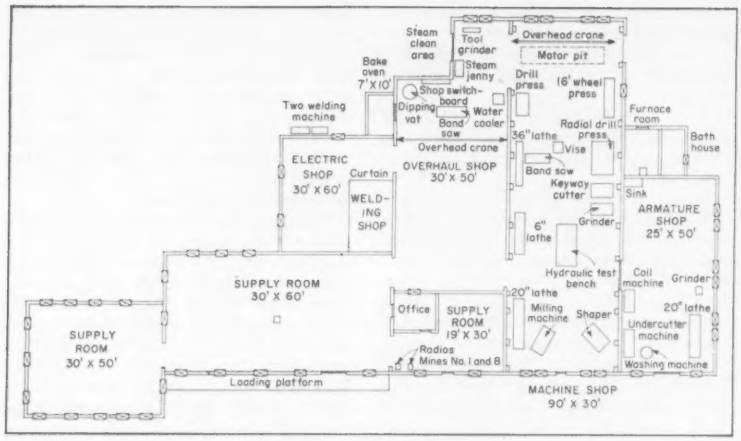
While, as noted, shops vary widely in character and facilities, certain practices and equipment lead to higher quality of work at lower cost. These include: good light, convenient lockers and work benches, special benches and stands for certain work (shuttle-car wheels, for example), supply depots in the shops themselves or at least close at hand, hoisting equipment for lifting and moving anything heavy, including such things as shafts into lathes, and power-operated tools—impact wrenches, etc. Cleaning and degreasing equipment contributes greatly to comfort and efficiency.

Other facilities included in the design of a main shop are a foreman's office, supply room, showers and lockers for personnel and separate section for electrical department.

While design and shop facilities influence quality of work and efficiency, the need for qualified supervisors and skilled workers also must be considered. A good shop must not only be well equipped but must have men that can do the work.

Mine Shops

Although a few deep mines make a practice of maintaining machines up to the stage of semi-overhaul in the working section, lack of space, the difficulty of doing welding, light and coal dust, among other things, normally dictate the transfer of major repairs replacement of assemblies and semi-overhaul to shops maintained for that purpose. Some of these conditions do not prevail in strip pits, and consequently there is a greater opportunity for doing second-echelon work away from the shop. And with large stripping units, the only practical way to work on them is in the field in special repair areas, though some components and assemblies are processed in the shop or shops. In preparation, also, the nature of the



CENTRAL SHOP AND SUPPLY HOUSE combination speeds overhaul work and reduces inventory. Shop is laid out so that specialized work can be performed in assigned work areas. Shop design plays an important part in a maintenance setup.

plant and equipment also dictates doing a major part of the work on the job, though parts and assemblies may be removed for shop repair and return.

DEEP-MINE SHOP LOCATION—Distance and whether or not the equipment must be hoisted up slopes or shafts are among the factors involved in location of deep-mine shops. A third is facilities for quick moving of units from the face to the shop and back, such as, special transporters. Where good transportation facilities exist, and hoisting is not involved, it may be possible to locate mine shops on the surface and thereby get the advantage of space, natural light and the like, including convenience, at a somewhat smaller expenditure. But where the distance is great, and where hoisting is involved, there are strong reasons for locating the shops underground. With proper planning and design, they can be made almost as convenient as surface shops —and as efficient—and have the major advantage of being closer to the actual working sections.

Moving the shop as the mining location shifts also is possible with certain types of mining—contour in particular, as well as auger. Some such operations use small prefabricated buildings mounted on skids or trucks as shops or supply houses or both, moving the unit or units as needed as the mine opening moves around the outcrop.

STRIP-MINE SHOP LOCATION—Central location and convenient access from highways, both on the property and off, are among the considerations involved in locating strip-mine shops. Frequently, these considerations result in the shop being located with the other mine facilities, such as, the mine office and the preparation plant, especially since big units are necessarily repaired in the field, and trucks, tractors and small units can be brought in under their own power or by the use of transporters, even when they are not required to come to the preparation plant regularly. An exception might be a truck garage and shop where the trucks haul to field stations or to rough cleaning plants moving coal to central plants by rail after rough cleaning.

SHOP FACILITIES—Even the simplest deep-mine shop for major repairs, replacement of assemblies and the like should be equipped with a pit, hoisting facilities and a parts store room, plus the necessary special tools required for the work done. Parts-cleaning equipment should be installed if possible to speed up this operation and facilitate subsequent work.

At the other end of the scale, mine shops may be large and elaborate and able to handle everything up to complete dismantling and reassembly of all types of machines. One shop of this type, located near the bottom of the hoisting shaft, includes high-intensity lighting, a general repair section with two pits plus overhead cranes and small hoists, two bays for shuttle-car service with hoisting facilities, an office, cabinets for parts a room for repair and servicing of shuttle-car wheels and hydraulic-jack units with monorail crane, and a cleaning recess with permissible-type steam cleaner supplemented by a refuse stall.

Tools include saw, floor-type drill press, vises, bench drills, floor grinders, hydraulic press, welding machines, and portable electric and air grinders. Facilities also include 32 tool cabinets built into the walls, and a compressor.

IN-PLANT FACILITIES—Though not a part of shops, certain permanent facilities of a shop type serve very useful purposes in certain maintenance applications. Examples are compressed air and welding gas lines and outlets in preparation plants, and arc welders in preparation plants and strip shovels. Time saving is the major advantage.

Mobile Repair Units

The repairman's jeep, with space for carrying parts and supplies and lockers or compartments for tools, has become a fixture at many underground mines because of the speed with which it can deliver both men and materials to the scene of a breakdown. Similar units also speed up the work of wiremen, bratticemen and other service workers. Other mobile maintenance units include welding trucks—gas and electric—where there is an opportunity to use such equipment in fresh air.

DEEP MINES—Skid-mounted "maintenance centers" are among the newer types of mobile repair units. Designed particularly for trackless mining and moved by hitching them to a shuttle car, the centers consist of 4x5x12-ft steel tanks with flat tops providing bench surfaces for work. Among other advantages, a supply of spare parts is always within 100 ft of the face.

For bringing machines to fresh-air locations, and for other purposes, including moves, crawler-mounted pullers or carriers have been found very useful at a number of mines, especially in low coal. And where machines must be moved long distances, such as loaders, miners and shuttle cars to main shops, lowbed transporters speed up the operation and save wear and tear on the units.

STRIP MINES — Mobile maintenance equipment at one strip operation includes the following, aside from greasing and fuel trucks:

Small-tool truck for all types of small hand tools and parts normally required on maintenance jobs.

Large-tool trailer for transporting heavy tools required in major jobs on big stripping units.

Flat trailers for moving wood blocks, cribbing and the like.

Special heavy-duty trailer for hauling buckets and shovels up to 100 tons.

Small-parts truck.

Truck-mounted crane with boom sufficiently long to handle all lifting jobs necessary in maintaining 40- to 50-yard shovels.

Welding trucks.

COMMUNICATION—If for no other reason, a good communication system from the face or pit to the main office and repair shop normally will pay for itself through reduction in breakdown losses alone. In strip pits, two-way radio is one of the answers, and includes certain mobile units in the superintendent's car, the repair foreman's car or truck, and the cabs of the key stripping units, among others. A good telephone or trolley system yields the same results in deep mines.

Lubrication

Establish a lubrication schedule and standardize on the number of lubricants used.

Provide necessary equipment for applying lubricants properly.

Keep seals and fittings in good condition.

Have reports and records kept on all lubrication.

A GOOD LUBRICATION SYSTEM will contribute greatly to reducing maintenance costs (labor and material) and production breakdowns.

Responsibility

Attainment of an effective lubrication system requires acceptance of perhaps three responsibilities.

1. Selection of lubricants and lubrication equipment.

2. Establishment of a lubricating schedule.

3. Application of lubricants.

Lubricant Selection

Selection of lubricants normally falls on the maintenance department, though the importance of lubrication might well warrant the employment of a lubrication engineer—at least where a company operates several mines and a large number of producing units.

The recommendation of the equipment manufacturer is the starting point in lubricant selection, with the second major source of data the service departments of the oil companies. A third source of information, provided proper records are kept, are the lubricating and delay reports, which may indicate that a change in type is necessary. When all the preliminaries are completed, lubricants then should be bought on performance rather than on general representations, and the rule should be the highest possible quality in view of the penalties now suffered as a result of equipment breakdowns.

STANDARDIZATION—Too many types of oils or greases lead to confusion, misapplication, contamination and loss. Careful study of the lubricating problem will show, in many instances, that a lesser number of types of high quality will do the job, since the variety of lubricants available include many with the necessary spread in characteristics fitting them to several applications.

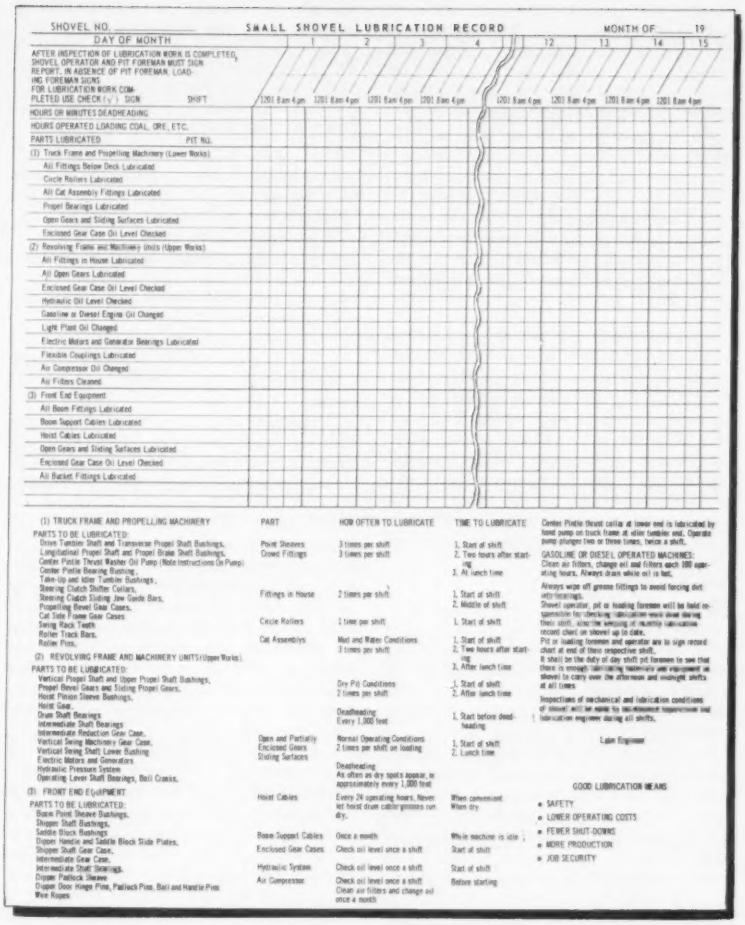
As an example of what standardization can accomplish, one large stripping organization, also operating a large and modern preparation plant, cut the number of lubricants from 29 to 9, as follows.

	Types	
	Before	After
Motor oil, heavy-duty detergent	2	1
Gear oil, all enclosed gear cases	4	1
Antifriction-bearing grease		1
Plain-bearing grease	5	1
Open gears	3	2
Cable dressing	5	1
Compressor oil	3	1
Hydraulic oil	7	1
Totals	29	9

Scheduling

Scheduling, with attendant reports and records, is perhaps one of the most-vital elements in efficient lubrication, and here again the responsibility rests on the maintenance department or the lubrication engineer.

An efficient lubrication program depends upon definite scheduling of the work, accompanied by definite instruction as to the type of lubricant to be used. This means a written document for the information and guidance of all who have anything to do with lubrication, and this document may also serve as a report on work done. Tags enclosed in plastic envelopes may, for example, be tied to tractors, with one side of the tag showing points to be lubricated, type of lubricant to be used, and when lubrication is to be done, and the other side serving as a record of lubrication performed. Similarly, more comprehensive schedules may be posted in strip shovels and preparation plants, or supplied to foremen and mechanics underground.



SHOVEL NO. _____ SMALL SHOVEL LUBRICATION RECORD MONTH OF _____ 19

DAY OF MONTH 1 2 3 4 ... 12 13 14 15

AFTER INSPECTION OF LUBRICATION WORK IS COMPLETED, SHOVEL OPERATOR AND PIT FOREMAN MUST SIGN REPORT. IN ABSENCE OF PIT FOREMAN, LOADING FOREMAN SIGNS FOR LUBRICATION WORK COMPLETED USE CHECK (√) SIGN

SHIFT 12:01 8 am 4 pm | 12:01 8 am 4 pm | 12:01 8 am 4 pm | 12:01 8 am 4 pm | ... | 12:01 8 am 4 pm | 12:01 8 am 4 pm | 12:01 8 am 4 pm | 12:01 8 am 4 pm

HOURS OR MINUTES DEADHEADING

HOURS OPERATED LOADING COAL, ORE, ETC.

PARTS LUBRICATED PIT NO.

(1) Truck Frame and Propelling Machinery (Lower Works)
- All Fittings Below Deck Lubricated
- Circle Rollers Lubricated
- All Cat Assembly Fittings Lubricated
- Propel Bearings Lubricated
- Open Gears and Sliding Surfaces Lubricated
- Enclosed Gear Case Oil Level Checked

(2) Revolving Frame and Machinery Units (Upper Works)
- All Fittings in House Lubricated
- All Open Gears Lubricated
- Enclosed Gear Case Oil Level Checked
- Hydraulic Oil Level Checked
- Gasoline or Diesel Engine Oil Changed
- Light Plant Oil Changed
- Electric Motors and Generator Bearings Lubricated
- Flexible Couplings Lubricated
- Air Compressor Oil Changed
- Air Filters Cleaned

(3) Front End Equipment
- All Boom Fittings Lubricated
- Boom Support Cables Lubricated
- Hoist Cables Lubricated
- Open Gears and Sliding Surfaces Lubricated
- Enclosed Gear Case Oil Level Checked
- All Bucket Fittings Lubricated

(1) TRUCK FRAME AND PROPELLING MACHINERY	PART	HOW OFTEN TO LUBRICATE	TIME TO LUBRICATE
PARTS TO BE LUBRICATED: Drive Tumbler Shaft and Transverse Propel Shaft Bushings, Longitudinal Propel Shaft and Propel Brake Shaft Bushings, Center Pintle Thrust Washer Oil Pump (Note Instructions On Pump) Center Pintle Bearing Bushing, Take-Up and Idler Tumbler Bushings, Steering Clutch Shifter Collars, Steering Clutch Sliding Jaw Guide Bars, Propelling Bevel Gear Cases, Cat Side Frame Gear Cases Swing Rack Teeth Roller Track Bars, Roller Pins,	Point Sheaves Crowd Fittings	3 times per shift 3 times per shift	1. Start of shift 2. Two hours after starting 3. At lunch time
	Fittings in House	2 times per shift	1. Start of shift 2. Middle of shift
	Circle Rollers	1 time per shift	1. Start of shift
	Cat Assemblys	Mud and Water Conditions 3 times per shift	1. Start of shift 2. Two hours after starting 3. After lunch time
(2) REVOLVING FRAME AND MACHINERY UNITS (Upper Works) PARTS TO BE LUBRICATED: Vertical Propel Shaft and Upper Propel Shaft Bushings, Propel Bevel Gears and Sliding Propel Gears, Hoist Pinion Sleeve Bushings, Hoist Gear, Drum Shaft Bearings Intermediate Shaft Bearings Intermediate Reduction Gear Case, Vertical Swing Machinery Gear Case, Vertical Swing Shaft Lower Bushing Electric Motors and Generators Hydraulic Pressure System Operating Lever Shaft Bearings, Ball Cranks,		Dry Pit Conditions 2 times per shift	1. Start of shift 2. After lunch time
		Deadheading Every 1,000 feet	1. Start before deadheading
	Open and Partially Enclosed Gears Sliding Surfaces	Normal Operating Conditions 2 times per shift on loading	1. Start of shift 2. Lunch time
		Deadheading As often as dry spots appear, or approximately every 1,000 feet	
(3) FRONT END EQUIPMENT PARTS TO BE LUBRICATED: Boom Point Sheave Bushings, Dragon Shaft Bushings, Saddle Block Bushings Dipper Handle and Saddle Block Side Plates, Dragon Shaft Gear Case, Intermediate Gear Case, Intermediate Shaft Bearings, Dipper Paddock Sheaves Dipper Door Hinge Pins, Paddock Pins, Bail and Handle Pins Wire Ropes	Hoist Cables	Every 24 operating hours. Never let hoist drum cable grooves run dry.	When convenient When dry
	Boom Support Cables	Once a month	While machine is idle
	Enclosed Gear Cases	Check oil level once a shift	Start of shift
	Hydraulic System	Check oil level once a shift	Start of shift
	Air Compressor	Check oil level once a shift Clean air filters and change oil once a month	Before starting

Center Pintle thrust collar at lower end is lubricated by hand pump on truck frame at idler tumbler end. Operate pump plunger two or three times, twice a shift.

GASOLINE OR DIESEL OPERATED MACHINES: Clean air filters, change oil and filters each 100 operating hours. Always drain while oil is hot.

Always wipe off grease fittings to avoid forcing dirt into bearings.

Shovel operator, pit or loading foreman will be held responsible for checking lubrication work done during their shift, since the keeping of monthly lubrication record chart on shovel up to date.

Pit or loading foreman and operator are to sign record chart at end of their respective shift.

It shall be the duty of day shift pit foremen to see that there is enough lubricating materials and equipment on shovel to carry over the afternoon and midnight shifts at all times.

Inspections of mechanical and lubrication conditions of shovel will be made by lubrication supervisor and lubrication engineer during all shifts.

Lube Engineer

GOOD LUBRICATION MEANS
- SAFETY
- LOWER OPERATING COSTS
- FEWER SHUT-DOWNS
- MORE PRODUCTION
- JOB SECURITY

LUBRICATION EFFICIENCY is promoted by definite scheduling and reporting, as with this form for small shovels. The advantages of this type of report cannot be over-emphasized.

Application

A key item in lubrication is getting the job done. Responsibility may be placed on the maintenance department alone or may be shared by the maintenance department and the machine operators and/or section or pit mechanics and electricians. The lubricating system varies with the type of machine and when and where it is used. The three general systems are:

1. Hand Lubrication. This usually involves grease guns or spout-type or other oilers for fluid lubricants. Where this is the practice, lubrication normally is handled by either the machine operator or the mechanic or electrician assigned to the machine or section, or by a special oiler, as with large stripping units. Lubrication can be combined with inspection and running maintenance, as with belt conveyors underground, for example.

Hand lubrication involves more transfers and containers, as a rule, and makes for more complicated distribution in addition to increasing the risk of contamination.

An improvement in small hand gun reloading is the use of manufacturer-filled grease cartridges, which reduces the reloading time and eliminates contamination.

2. Lubricating Trucks and Special Crews. Such trucks are used both underground and at strip pits. Hand lubrication may be desirable for several reasons including low working height, cramped quarters, or the type of unit, such as, a belt conveyor. However, since individuals with other duties frequently are called upon for lubrication under this system, the chance of human error is greater. Hand lubrication also increases the chances of contamination, and may require stopping the units during the working periods, thus reducing output.

The preceding are among the reasons why a number of mines have placed responsibility for lubrication on special crews and have provided them with lubricating trucks. A typical underground truck usually is operated by a crew of two men, who visit all units in the mine or a section of the mine once a day on the off shift. The truck usually is equipped with tanks for two types of lubricants, with a third tank for hydraulic oil, and may be provided with hoses for blowing fittings, motors and the like as necessary with air from the compressor used in dispensing the lubricants. Where the truck is track-mounted and offtrack equipment is em-

ployed, the offtrack equipment may be brought to the loading station once a week, for example, for thorough inspection and lubrication, with lubrication by hand at other times. The truck crew also fills lubricant containers for hand lubrication.

Trucks for strip equipment also may include fuel-dispensing equipment. One such unit comprises a gas-powered compressor, lubricating pumps, four lubricating hoses on reels, and four fuel drums with the necessary hoses. Air pressure is used for dispensing fuel as well as lubricants, and the unit serves tractors, drills and other smaller mobile units.

3. Centralized Automatic Lubrication. Minimum manpower and positive lubrication at all times are among the reasons for the rise in use of centralized automatic lubricating systems in coal mining. These systems dispense either grease or oil—more usually grease—and among other advantages reduce the chances for contamination to almost nothing, since the lubricants usually are dispensed from the original containers or if not, with a minimum number of transfers.

Reports and Records

Unless somebody checks, adhering to an efficient system in lubrication, as in all other activities around the mines, is practically impossible. This means reports and records which, even though they involve paper work, provide the basis for intelligent operation and control.

Reports may be rather simple in nature, merely recording that a certain machine was lubricated on a certain date. An important item in any report, however, is whether certain bearings refused to take lubrication or took too much, since this is a signal that trouble is probably in the making. A rise in quantity used on each machine or in each application is a further signal that machine condition is deteriorating, or that certain parts need attention. And if experience has shown that adequate lubrication can be secured with certain quantities of materials, figures on quantities used also will reveal waste and loss through contamination or otherwise.

Rated Voltage

Keep substations within maximum transmission distance to working sections.

Limit the amount of trailing cable on machinery.

Check voltage regularly with recording-type instruments.

Furnish necessary supplies to repair cables and keep a spare cable handy.

IT IS DIFFICULT to overemphasize the importance of rated voltage at the motor terminals as a factor in maintenance—and in unit production. DC motors, for example, tend to slow down almost in proportion to voltage drop, and slow-acting machines, plus frequent cable and armature failures, tend to result in don't-care operators.

When trailing cables or motor conductors are subjected to high current overloads—one result of reduced voltage—the resistance of the copper conductors increases, the cable drop rises, the voltage to the machine is further reduced, the machine automatically calls for more current with added heating, and the vicious circle continues—possibly to the point of cable or motor failure. Under extreme conditions, copper can be heated to 600 F or higher, at which point it will burn even if nothing else fails before.

Maintaining Voltage

The causes of low voltage include:

1. Substations too far from the working face (see article on electric power for recommendations on maximum distances).
2. Excessive cable length.
3. Inadequate feeder and return capacity.
4. Cables too small.

In addition, excessive heating results from the following:

1. Layering on reels or in piles decreasing cable rating because of inadequate air circulation.
2. Inadequate or no overload protection. Properly rated fuses or properly set circuit breakers should be used.

Regular voltage checks therefore become a necessity in preventive or production maintenance, and may even warrant the use of recording-type instruments at strategic locations. Otherwise, the section electrician may well be charged with the responsibility for making regular checks. And to make these checks effective, a program of moving up substations and beefing up feeders and returns as necessary must be followed. This might well be the responsibility of the chief electrician, maintenance supervisor or electrical engineer.

Since even under the best of conditions heat is generated when current flows in conductors, and the higher horsepowers now being employed in the same or only slightly larger space aggravate the problem, the best in motor and cable insulation should be employed, such as asbestos-fiber compounds, silicone and the like. Blowing motors is a well-established method of keeping them cool in certain types of service, and cooling by water jackets is coming into the picture for certain motors subjected to the most-severe duty, as on continuous miners.

Cable Maintenance

Even with rated voltage, delivery of the necessary power to the operating machines usually involves a trailing cable of some type. Aside from low voltage and overload, the major causes of cable failure, particularly underground, are:

1. EXCESSIVE TENSION — Install spring-type shock absorbers, keep proper tension on reel, adjust reel to prevent back spooling.

2. MECHANICAL DAMAGE — Avoid running over cables, replace broken sheaves and guides, avoid pinching cable.

In the event a cable fails in spite of all precautions, reducing the time lost requires quick restoration of the service. Some ways of doing this are:

1. Use of compression connectors and special hand or power tools for quick connection of the power and ground wires to save time. Special portable welding equipment also is used to make splices electrically. A fairly common failure is trying to keep a cable with too many splices or otherwise in less than top-grade condition in service. The cost of the delays in some instances will repay the cost of a new one in as little as 2 to 4 days.
2. Use of spare cables to permit quick replacement of the entire cable. An alternative with at least certain types of equipment is the use of sectionalized cables, which not only are easy to install but also lend themselves to the quick replacement of a new section for one that has failed.

Temporary splices should be kept to a minimum. One rule allows six, after which the cable is removed and sent to the shop for rebuilding by permanent welded or compression-connected splices and vulcanizing. Some mines remove the cable with a lesser number of splices.

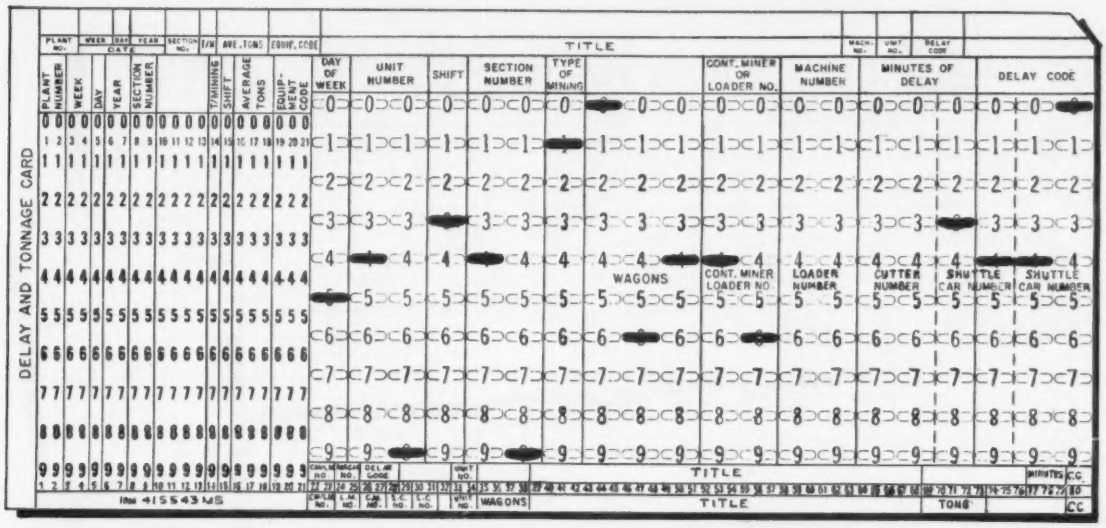
Maintenance Materials

Use hardsurfacing materials whenever possible.

HARDSURFACING PRODUCTS are an example of materials that cut maintenance cost by increasing the life of machines and parts subject to wear, reducing the number of replacements and consequently saving not only in parts and materials but also in labor for replacement.

Examples of the other materials and parts that may be employed to lengthen machine and part life, reduce breakdown time and cut the cost of maintenance include:

1. Stainless and other alloy steel, aluminum and so on for strength, light weight and corrosion resistance in mine cars, truck bodies, stripping dippers, cages and skips, and so on. Light weight, provided there is the requisite strength, in itself reduces the maintenance load, or light weight with high strength permits building up parts without increasing total weight, thus reducing the chances of failures.
2. Stainless steel, manganese-steel and bronze for reducing wear and corrosion in coal screening and other coal-handling process.
3. Special alloys, bronze, rubber, other corrosion- and abrasion-resisting materials for pumps, valves, fittings and other equipment handling water and water with various solids.
4. Use of lime, by means of automatic feeding equipment, in wet-preparation plants where acid is a problem to reduce corrosion.
5. Cast iron, alloy, asbestos-cement, lined or plastic pipe for mine and other water lines to resist acid.
6. Rubber, tile, sprayed and sand-cement and other corrosion- and abrasion-resisting materials for tanks and storage bins. Some companies have made complete bins of steel-supported glazed tile to resist the effects of abrasion and corrosion.
7. Glass, stainless steel and other wear-resisting materials for chutes, conveyor bottoms.
8. Aluminum, protected-metal and other weather-resistant siding and roofing for preparation plants and other structures.
9. Protective coatings and paint where needed.
10. Silicone, asbestos and other long-lived heat-resistant insulation for electrical equipment.



PUNCH CARDS provide a new method of controlling inventory and reducing supply costs. Great variety can be had in the manner in which information is collected. Automatic machines do the processing.

Profitable Supply Control

INCREASED INVENTORIES resulting from the use of more and more mining and preparation equipment, higher costs of parts and materials and a faster turnover of supply items make a good supply system an economic necessity in the industry.

Cost of parts and materials make up a large part of the cost of coal. An average of 85c per ton goes for supplies. The low, usually at the smaller operations, is as little as 40c per ton or less and the high is over $1. It is quite possible that the average supply cost per ton of coal will increase considerably within the next few years.

The need for a good supply system, close inventory control and more detailed reports on the use of parts and materials by machine and by working sections is becoming more of a must than a routine function.

An adequate flow of parts and materials is required to keep machines and men working. A good supply system promotes efficiency and lowers cost in five major ways:

1. Machines and men are able to produce more by the elimination of interruptions resulting from lack of parts and materials.
2. Inventory is controlled and kept to a minimum.
3. Parts and materials are received, stored and delivered at minimum cost.
4. Waste prevention and loss of parts and material are controlled.
5. Fewer office workers are needed to process incoming and outgoing supplies and to make reports.

Goals

Eliminate prolonged production delays resulting from lack of parts and materials.

Keep inventory down but not to the point where essential parts are exhausted before reordering.

Provide materials-handling facilities to reduce labor costs.

Control waste and loss of parts and materials.

Ways and Means

Establish an inventory-control system to meet the most exacting requirement of each operation.

Compile detailed reports on the use of parts by each major machine.

Keep an adequate supply of items on hand that are essential in controlling the cost of coal production.

Regulate the quantity of supplies by reordering on time.

Plan storage layout for efficiency, convenience and protection.

Provide necessary parts and material at or near the point of use.

Make studies to determine type and quantities of supplies.

Provide facilities for supply delivery on the surface and underground for quick delivery with minimum labor.

Reduce waste and loss of parts and materials by setting up rules and standards with a follow-through approach.

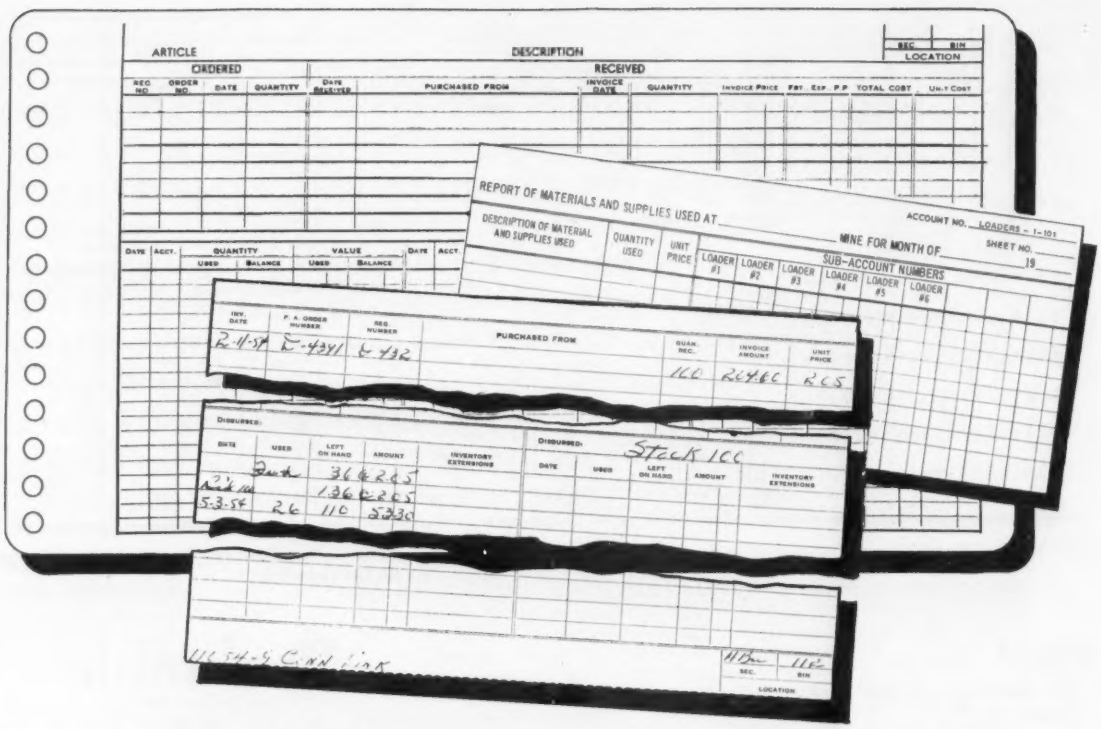
Practice Trends

Automatic office machines more widely used to control supply inventory and cost, and provide more accurate records and reports in less time and with less manpower.

Increased cost of parts and materials reflected in strong emphasis on close inventory control.

Going beyond the standard "supply-distribution report" and requiring more detailed reports on the use of parts and materials by machine and by working section growing as a means of more effectively controlling cost.

Trend to central supply houses to serve multimine operations gathering momentum for economy reasons. Advantages include reduction in total inventory and opportunities for buying supplies in larger quantities at reduced prices.



PERPETUAL-INVENTORY CARDS (top and bottom) are for loose-leaf ledger and tray-type files. A complete record of supply receipts, quantity on hand, disbursements and costs requires only two forms, thus simplifying inventory and minimizing clerical work. Monthly use report (center right) lend themselves to summaries by account of function numbers, or by individual units to keep track of parts costs.

Control Systems

Consider the possibility of adopting automatic office machines and computers for controlling not only supplies but for doing many other functions related to supply control.

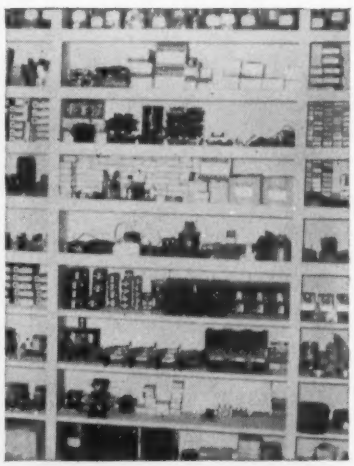
Establish the "perpetual" inventory control system as a second choice if computers are not adaptable to your individual operation.

Automatic Office Machines

The use of automatic office machines, such as computers, sorters, verifiers, etc., provide better control of inventory and supply cost. Lower office cost and the elimination of time-lag in preparing reports also are important features.

Several types of automatic office machines are available for these purposes. They have remarkable speed and flexibility.

An integrated data-processing system using set methods and machines can provide considerable savings in the supply setup and also in the overall mine operation. Supply-cost reports produced by machines can provide a foundation on which to build a cost-reduction program. The machines not only produce reports which make fixing of cost responsibility possible but the reports disclose where action is necessary to stay within objectives. Action can include such things as elimination of waste, development of better methods, improvement of maintenance techniques, requests to suppliers and manufacturers for better materials, dissemination of pertinent information and so on.



ADEQUATE SHELVING promotes classification of parts and good housekeeping.

Perpetual Inventory

Companies have largely settled on the "perpetual" system of inventory control. Basically, it provides a running record of (1) quantity and cost of units and materials received, (2) quantity and cost of units and material issued, and (3) quantity remaining on hand at all times.

This information is contained on cards at each bin or on tray-type cards filed in loose-leaf ledgers or metal cabinets

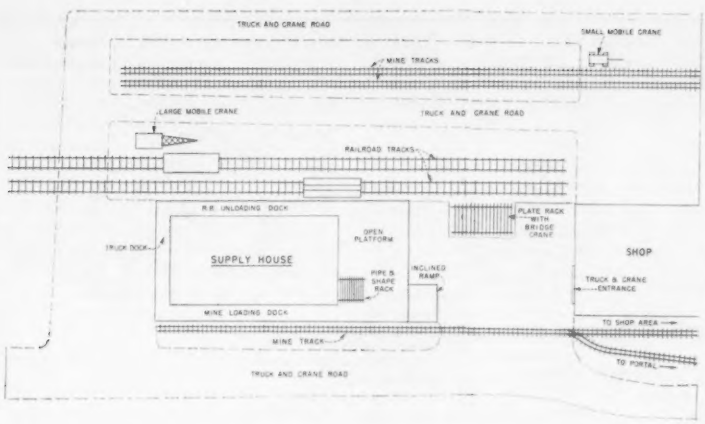
FILE CARDS—The file-card system is the handiest and surest method of inventory control. It reduces the possibility of running short of supplies through failure to note that the time for reordering has come.

Inventory cards may be made up specifically by a mining company to meet its own needs, or cards, files and systems may be purchased from specialists in business machines and business records, who can, if desired, provide forms and equipment for even punch-card tabulating and record-making where the number and volume of supply items is large.

The accompanying illustrations show two types of cards provided by business-record specialists. One is designed for ledger use and the other for tray-type files. Both give a complete record of each supply item.

RUNNING RECORDS—The system provides a running record of activity in supplies, and also an easy means of making periodic summaries of use. Most companies prefer to have all supply items listed in the system. However, when there are exclusions, such as timber, it becomes necessary to make sure that (a) the items are not overbought, (b) that the quantity is not permitted to drop below the danger point, and (c) that data are supplied for the periodic supply-use and inventory reports.

REORDER AND USE INDICATORS—To facilitate reordering and filing reports on the use of parts, supplies and materials, cards with "flags" or colored tabs can be used.



Storage Layout

CONVENIENCE, EASY ACCESS AND PROTECTION feature yard designed for truck and mobile-crane operation with receiving and loading docks on three sides. The principles illustrated include:

1. Receiving and loading dock completely surrounding the warehouse. This is a practice that can be followed if desired, but it may not always be necessary to surround the supply house with docks, though provision should be made for sufficient dock space both for receiving and for loading mine equipment. The docks in the setup illustrated are at the right height for receiving material from railroad cars or trucks, and for loading materials into mine equipment without excessive lifting or lowering.

2. Open storage planned so that as heavy material is unloaded it can be placed so that it is convenient for loading into mine equipment. Roads are located so that mobile cranes can be used for unloading railroad cars or for lifting heavy items out of storage into mine equipment. These same roads permit unloading such items as mine props and timbers directly to the mine trucks if desired.

3. Use of power-operated handling equipment. The mobile crane, with various attachments, including clamshell for sand and gravel, and fork for props, rails and the like, or other mobile handling units materially reduces labor and also the hazards involved in handling heavy parts and materials. With a fork-type grab, for example, two men can load a car of ties in less than 1½ hr. Aside from cranes, mobile handling units include motorized wheelbarrows, motorized high-lift, bucket-type loaders and carriers, high-lift fork trucks, crane trucks and so on.

4. Open platform with inclined ramp provides open storage for certain parts and materials and also makes it easier to get equipment, such as, shuttle cars, loaders and the like out of railroad equipment and down to mine-track level. Handling of heavy items on the platform can be done with the mobile cranes, or the platform can be equipped with crane rails and a hoist. An alternative is a crane track extending out of the supply house to the platform both for handling materials on the platform, or for moving them inside to floor storage.

The plan illustrated also shows an open plate storage with traveling crane and hoist. Plates are stored on edge between stanchions.

A green plastic tab, for example, on the card may be slid to the center the first time an item is issued in a monthly or other report period, and a red tab on the opposite side also may be slid to the center as an indication that the item is to be reordered when the next requisitions on the purchasing department are prepared. The flags make it unnecessary to check each card for either preparation of the distribution report or for reordering.

Supply Receiving

A new receiving system (*Coal Age*, September, 1957, p 73) eliminates delays in reporting receipt of shipments, which result in the delay of payment of invoices with the possibility of missing out on discounts. All necessary papers are prepared in a single writing by means of a portable register. It consists of four parts:

White—Invoice clerk's copy with freight or express bill attached.

Green—Cost clerk's copy.

Blue—Requisitioner's acknowledgment.

Salmon—Requisitioner's copy for filing.

Physical Inventory

Accurate records of receipts, cost and use are essential for wise and economical use of supplies. Regardless of the supply-control system employed, it should be supplemented by an actual physical inventory if supply cost and production time are to be reduced. Inventories are usually taken at 6- and/or 12-mo intervals.

Records and Reports

Compile detailed reports of all data that will serve useful purposes.

Beware of over-reporting. Too many reports and repetition of data will result in over-staffing the department and loss of effectiveness of essential reports.

THE STANDARD "supply-distribution report" and detailed reports on the use of parts and materials by machine and by working section are increasing in importance. For convenience, each equipment class or mining function is provided with an account number.

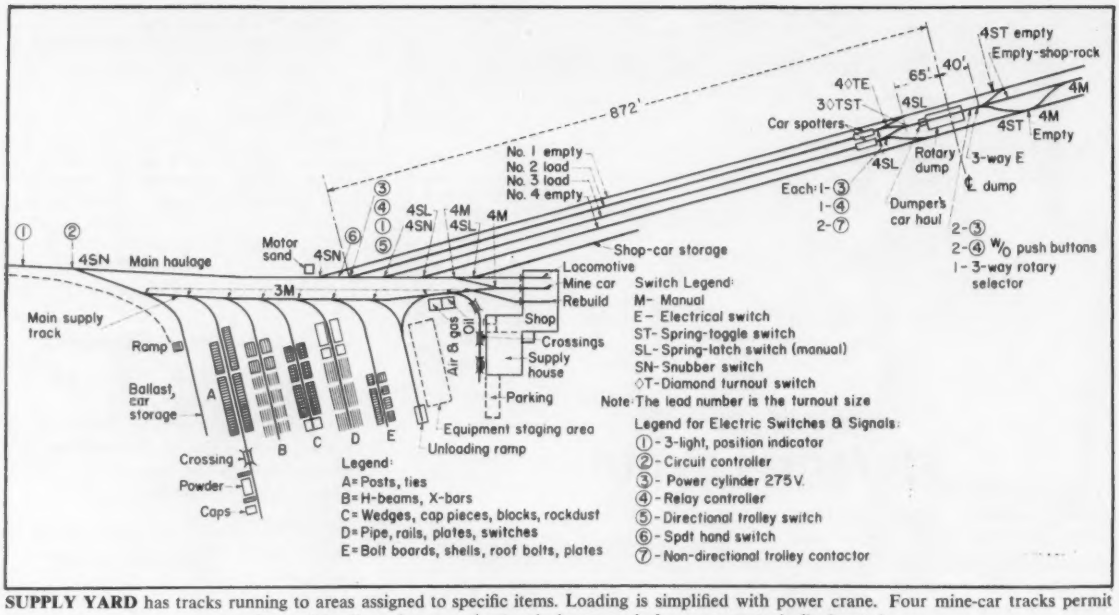
ACCOUNT NUMBERS—A standard coding system for automatic office machines must be developed to provide adequate descriptions of the various supply transactions so that costs can be accumulated on specific items and developed into general group totals.

The supply-cost code should contain sufficient digits to permit cost reports to be expanded, if necessary. More accuracy, greater detail and a lower cost per report will result. The code usually is in three parts or more. Numbers from each part must be selected and combined to describe a transaction.

For other systems the daily or other delay reports using account numbers provide —at least by inference—sufficient information to determine whether supplies are being used properly and economically. On the other hand, the more detailed system requires definite and positive information to prevent waste and loss through abuse and carelessness.

ORDER FORMS—Order forms, reports and records are essential for the proper evaluation of supply use. Nothing should be issued without an order, properly signed, stating what is wanted and where it is to be used. For a check and appropriate action, summaries of supply use should be prepared at regular intervals for the information and use of mine and operating management.

MONTHLY DISTRIBUTION REPORTS—This is one form of report to mine and operating management. Where more detailed data are desired the form or forms may be expanded to show items charged out to each machine, to each working section and to each general function, thus indicating whether abuse is running up parts cost or whether certain sections are taking more supplies than necessary.



SUPPLY YARD has tracks running to areas assigned to specific items. Loading is simplified with power crane. Four mine-car tracks permit storing or blending of raw coal. Supply house and shop are strategically located.

SUPPLY-COST REPORT—The supply-cost report should be so detailed that supply costs can be analyzed from final total to subtotals and specific items. It should show the cost per ton of coal (dollar value) and quantities for specific accounts, and should be done for the month and the year to date.

SUPPLY COST SUPPLEMENT — This report shows the cost of various machine subassemblies which is broken down into costs of individual parts. The part name, quantities for the month and year to date, dollar amounts for the month and year to date, units of issue and unit prices are included in this report.

SUPPLY COST COMPARISON—This report is prepared at the end of the year. It shows cost-account numbers and their costs per ton for each mine or section. It is extremely effective in improving performance of the various mines or sections. Comparisons show good and bad points and promote the exchange of ideas and new objectives.

CENTRAL-SHOP COST REPORT—The overhaul report is prepared monthly for work done in the central shop. It shows the total cost, cost charged to each mine and the cost charged to each machine on which work was done. These charges are all subdivided into costs for labor, overhead and supplies for the month and year to date.

COMPANY SUPPLY CHARGES—This is a resume of charges against supply costs by various organizations within the company each week. Each mine is covered individually. The purpose of the report is to assist in daily cost accounting at the mine and to provide a means of detecting errors in charges.



LOOSE-LEAF CARDS for the perpetual-inventory system are kept in ledgers to permit easy checking.

USE REPORT—This report shows machine part numbers and descriptions, quantities used at each operation, total quantities used by the company as a whole and the average unit prices. It is prepared quarterly for the quarter and year to date. It does not show the machine and subassembly types where the part is used.

SUPPLY STOCK REPORT—The part number and description, unit of issue, old balance, receipts, issues, new balance, quantity on order, total quantity on hand and on order, the established inventory level, quantity due out, and the quantity above or below requirements are shown in this report. It is used to adjust inventory and purchase quantities.

SPECIAL REPORTS—These reports may be required of certain officials and mine employees. For example, a single carbide-tipped cutter bit can cost $1.25 or more and, therefore, some operators feel that it is necessary to keep records on the amount used daily and the number on hand. Similar records could be required for other small and relatively costly items, such as, roof bolts, steel ties and the like.

To wrap up a detailed record system, it naturally should show transfer of certain materials from one working area to another, thus guarding against possible loss through carelessness or buck-passing. And if such things as timber are salvaged for use elsewhere, the records should show how much came out of a particular section and where it went as a means of gaging, among other things, the effectiveness of a salvage program.

Inventory Control

Make a list of the supplies that will be stocked including general mine supplies and parts and materials for all machines.

Determine the amount of supplies and parts to be stocked. Do not be too conservative. It is better, in most cases, to have a few too many than not enough.

Regulate supplies by reordering on time. A systematic approach to this problem will do away with empty bins.

Select a warehouse that will suit your present needs and allow for possible future expansion.

THE QUESTION most often asked about

supply inventory is: "What should be carried in terms of dollars and cents?" Actually there is no one answer. Inventory, if too high, means that money will lie idle. On the other hand too low an inventory can mean increased production delays and higher production costs. Among other things, the level of supplies at individual mines depends upon mine location and size. Inventories range from as little as $25 to $30 per ton of daily capacity up to $150 or more per ton at mines remote from manufacturing and distribution centers. The average appears to be in the neighborhood of $50 to $60 on hand per ton of daily capacity.

Control Factors

The inventory level involves a fair amount of personal judgment based on experience and an analysis of parts and supply use in relation to time for normal replenishment. Some of the factors involved in arriving at a solution include:

1. Cost of item or a class of items in relation to production cost increases incurred if the item is not on hand when needed—for example, spare armatures or motors. For instance, how much, at the most, would a rotor failure on the main shaker-screen motor involve in payments for nonproductive labor, for power for ventilation and pumping during the production interruption, and so on? And would the cost be reduced if a complete motor was on hand instead of only the rotor? Or should the possibility of a stator failure be the controlling one and thus dictate keeping a complete motor ready for replacement?

2. Rate of use in relation to time required to reorder and get delivery of replacements. Experience normally will indicate the rate at which, say, controller fingers of a certain type are used. If new supplies could be secured in a month, then the maximum on hand at any one time theoretically would be a month. Or, the total use in, say 6 mo, might be so small that it would pay to keep that much stock on hand to avoid the extra clerical and other effort involved in ordering more frequently—not to mention discounts for large orders.

3. Central warehousing vs. warehouses at individual mines. Where one company operates several mines, it normally is considered more economical to operate one central warehouse provided certain conditions exist. These include:

A. Reasonable distances from central warehouse to mines to keep down delivery time.

B. Good highways and good trucking facilities to permit fast deliveries.

Where these conditions exist, central warehousing, as noted, is considered feasible and economical, except for certain types of supplies, such as, timber, rail and the like. Of course, a certain volume of other parts and supplies must be kept at each mine and, in fact, at each deep-mine or pit face, to facilitate maintenance and prevent operating delays arising out of such things as lack of timber, etc.

4. Cooperative stocking. Where a part or a component is large and costly and requires considerable time to repair or, if completely wrecked, must be manufactured from scratch, it is possible for a group of companies in an area to buy one such component or part and rotate it around as needed.

5. Independent warehousing. Where manufacturers, their agents and independent supply houses have branch or main establishments close to the coal fields, maintain stocks of the desired items and provide quick delivery, it is possible to use them as the source for many items, thus cutting down on both inventory and on company-owned warehousing facilities.

6. Price trends. If one is willing to risk the hazards of estimating future trends, it may turn out to be desirable to run up the inventory of parts and supplies—at least in part—to offset expected price increases, or to curtail purchases in anticipation of decreases.

Storage and Handling

Plan storage layout for efficiency, convenience and protection.

Be sure that supply-house facilities include space for storing small and medium-sized items, hoisting equipment where necessary, push-type carts and so on.

Provide heat in winter and dehumidifiers in the summer in areas where electrical equipment is stored. This also could apply to many other items that are affected by the weather.

TYPE, SIZE AND COST of specific items normally dictate methods for receipt, storage and issuance. Thus, depending upon these factors, both enclosed and open storage are employed at mines. Enclosed or covered storage includes both regular supply buildings and also sheds for certain items requiring less protection.

Open or yard storage is satisfactory for timber, steel ties, rail and the like including heavy equipment items that are not appreciably affected by rust and other deterioration as a result of exposure to rain, snow, dust and the like. Where the items are made, for example, from copper and lend themselves to theft, enclosed storage normally is dictated to prevent losses of this type. Shed storage may be desirable for pipe structural shapes, plate and the like to prevent excessive rusting and also avoid difficulties with snow and rain in storing and handling. However, shed storage rules out, in most instances, the use of mobile cranes in handling such items, and the ability to use such equipment may outweigh the disadvantages of open storage.

Storage Layout

While the storage layout will vary from mine to mine, the plan shown in the accompanying diagram illustrates some of the basic principles involved in achieving efficiency, convenience and protection. In this instance, the shop is near the supply house and thus a separate shop supply is not required.

Supply-House Facilities

Supply houses include both bin storage for small or moderate-sized items, and floor storage for heavier units. The floor-storage facilities at one new supply house include a basement for cool storage of rubber-covered cable, conveyor belts and other rubber items. Access to the basement is by 25-ton hydraulic lift, large enough to handle even the heaviest reels of cable and belt, which can be rolled on and off.

Some supply houses include a monorail and hoist for handling heavy units into and out of the floor-storage area, and storage facilities for such heavy items, include, in addition to open floor, racks for, say, spare armatures.

Other facilities which have proved successful in simplifying the handling of supplies in warehouses include: sectional steel bins with adjustable shelves; drawertype and rotating bins for small items; clear plastic chest and drawer units for miniature units; shafts and reels mounted on walls or stanchions for convenience in paying out and measuring cable, hose, rope, etc.; peg racks for V-belts and similar items; and platform-top push trucks for moving items to and from bins, especially if the warehouse occupies a rather large floor space.

If bins are built up higher than eye-sight level or arm's reach, trolley or wheeled ladders or steps save time and reduce the possibility of injury. One wheeled step, for example, includes springs which gives when a man puts his weight on the steps and thus provides solid footing.

Light should be ample to read tags, nameplates and the like, and the sources should be placed so that it is relatively easy to see into the backs of shelves or bins, especially those high up.

Other ideas employed to facilitate storage and handling include: Easy access to bins, for safe and quick disbursement of parts by the use of permanent stairways and balconies. Monorails equipped with hoists and armature racks mounted on wheels (see illustration) save space and facilitate handling of heavy parts.

Allocation of Stocks

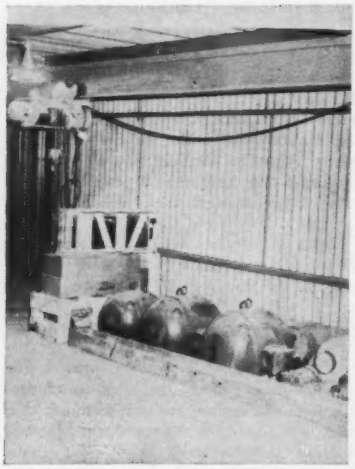
Keep essential parts and materials at or near the point of use. The amount and type of these items should be established on the basis of their effect on production if they are not close at hand when needed.

Supply, at or near the point of use, only those items necessary. If non-essential items are included, waste and loss of supplies will result.

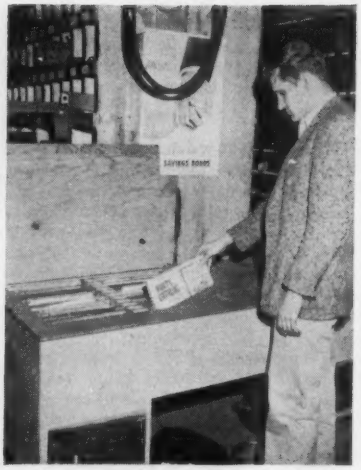
THE CARDINAL PRINCIPLES of stock allocation are: (1) make studies to determine type and quantities of parts and material necessary to keep production interruptions to a minimum, and (2) provide such supplies at or near the point of use.

Stocks of frequently used machine parts, for example, should be kept close to or in the pit or underground section for the use of the section or pit electrician or mechanic.

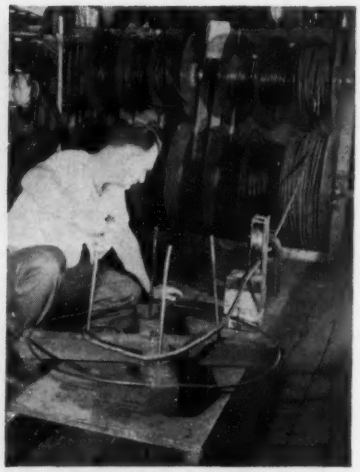
EQUIPMENT REQUIREMENTS—Once essential repair parts have been supplied, replacements for such stocks normally are charged to operating cost when they leave



STORAGE AREA for medium-sized motors is served by a hoist and monorail.



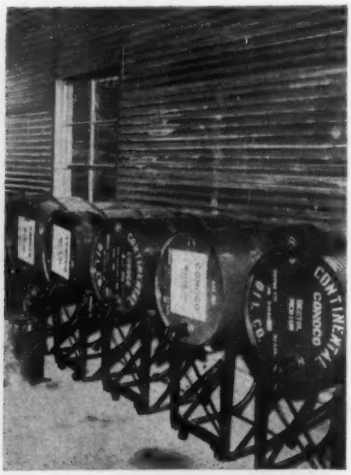
HANDY DESK equipped with filing compartment is used for parts catalogs.



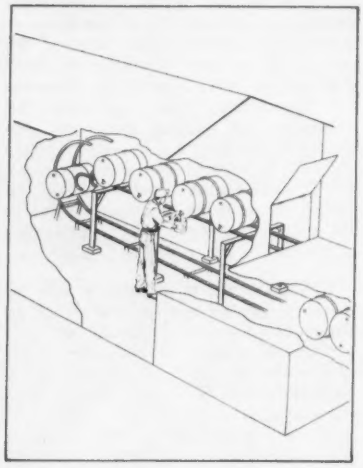
REELS FOR CABLES facilitates storing, handling and measuring out pieces.



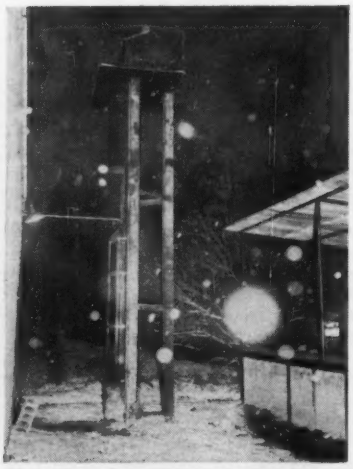
PORTABLE LIFT handles supply and equipment in shop and supply house.



OIL-HOUSE OPERATION is facilitated by caster-mounted tilting racks.



TYPICAL LAYOUT of an oil storage house permits easy handling of oil drums.



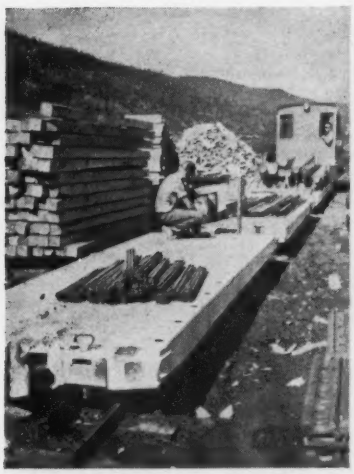
24-INCH BOREHOLE cuts time in getting small parts underground.



MECHANIZED EQUIPMENT speeds unloading of roof-bolts from truck into cars.



MOBILE CRANE with attachments handles heavy materials in the supply yard.



VERSATILE FLAT-BED TRUCKS facilitate supply delivery to working sections.



SUPPLY CAR EASES HANDLING of parts and supplies in thin seams.

the main supply house. If it is desired, as discussed previously, to keep accurate use records, the section or pit electrician or mechanic can file reports showing use of items by machine number, thus enabling operating management to keep track of where parts and materials go. Rather than a separate report, the section mechanic's or electrician's daily delay and repair report can show what items are used and where.

CENTRAL WAREHOUSING SYSTEM—Where two or more mines are involved and the central warehousing system is employed, allocation might be along the following lines:

1. Principal stock of repair parts at the central warehouse.
2. Subsidiary stocks at the central repair shop, provided it is not adjacent to the central warehouse.
3. Subsidiary stocks at the mine shops.
4. Section stocks in the working sections or pits for running repairs and maintenance.
5. Stocks of ties, timbers, roof bolts and similar items at the individual mines, since it is more convenient and less costly to have such materials delivered directly to the mines for storage and distribution rather than rehandling them from a central point. In fact, even where only one mine is involved, it may be more convenient to provide separate facilities for receiving, storing and distributing (a) machine parts and smaller items, and (b) larger, bulkier items used every day the mine runs.

Special Supply Houses

Design and locate powder houses in accordance with state and federal safety authorities and recommendations of the Institute of Makers of Explosives.

Set oil houses and oil-storage facilities apart from other surface units and build them of fireproof materials.

Provide sand houses with adequate capacity and locate them so receiving, drying and dispensing are controlled by gravity, if possible.

POWDER MAGAZINES, oil houses, sand-storage and drying facilities, and even portable or semi-portable pit or mine houses are considered as special supply facilities.

POWER MAGAZINE—Design and location of this storage facility is a matter of following the recommendations of state and federal safety authorities and the Institute of Makers of Explosives.

OIL HOUSES—There is good reason for putting oil houses and oil-storage facilities apart from other surface units. However, there is no reason why they cannot be located for easy receipt of supplies either by truck or rail. As a matter of fact, convenient, clean and safe facilities for dispensing are as much factors in oil-house design as storage.

Designs most nearly meeting these objectives include: steel and concrete construction, racks that hold drums in proper position for dispensing, hoists or other mechanical facilities for handling drums, and provisions for catching drip and spillage. Fixed racks should be provided with inclined ramprails to permit rolling drums up to position, unless chain hoists are used. Chain hoists, incidentally, make it easier to replace drums without handling of others, as do tilting-type racks with castors, which may be pulled out of position, run to the storage area and tilted to permit taking off the drum, after which the process is reversed to put a new drum into position.

An example of a well planned oil house is shown in the accompanying illustration (Texas Co., "Lubrication of Coal-Mine Machinery"). Note that oil drums are delivered on a platform at truck-bed level. After drums are emptied they are rolled to the end and under the top rack to the outside.

SAND HOUSES—Terrain and other considerations affect sand-house design and location. If possible, the facilities should include storage for a specified number of truck loads. In hilly country, where sand is received by truck particularly, it may be possible to build the road up on the hillside so that trucks can dump directly into the bin.

The preceding comments presuppose gravity flow from the wet storage bin to the drying stove or stoves, and from the stoves or dry-sand bins to the locomotives, sand cars or bore-hole to the mine-bottom. This gravity flow materially reduces labor in all phases of receiving, drying and dispensing sand, and this saving may warrant a substantial investment in bins and gravity-handling facilities which, in some instances, are almost or completely automatic.

Though not yet possible in too many mining areas, sand-handling facilities may be eliminated completely by depending upon outside suppliers for drying and delivery. At one operation, the custom drier delivers the sand in oil-type drums ready for movement into the mine.

PORTABLE SUPPLY HOUSES—Under certain circumstances, a "portable" supply house becomes quite convenient in addition to providing protection and promoting order in dispensing supplies—particularly machine parts. One circumstance is stripping where frequent moves are made from one location to another. Another is deep mining of the contour type, where the main opening keeps moving around the hill. Under such circumstances, a number of mining companies have bought small prefabricated buildings and mounted them on skids or trucks for towing from one location to another.

Supply Delivery

Provide facilities for supply delivery on the surface and underground for quick delivery with minimum labor.

SURFACE AND UNDERGROUND DELIVERY is the last operation of a supply control system. The methods and the equipment employed to deliver supplies are determined by local conditions and the overall supply setup.

Delivery Schedules

Delivery between supply house and shop where the two are not too far apart and are connected by a hard-surfaced roadway may be handled by hand-pushed lift cranes, motorized cranes or special motorized flat-bed trucks.

Supplies delivered from a central supply house to one or more mines usually are handled by motor trucks. It is important that order and delivery schedules be worked out. Requisitions from the various mines, for example, should arrive at the supply house at a designated time to permit the supply clerk to fill the orders before the supply crew is due to arrive.

Surface Delivery

The motor truck in its regular form is the work horse in supply and delivery on the surface. In its special forms, especially at stripping operations, it includes grease trucks—usually designed for actual application of the grease at the point of use as well—fuel trucks and utility trucks. And at some operations, the final stage in storage and delivery of explosives—at strip mines, for example—is handled by small rubber-tired units designed for towing on the bank by tractor, relieving the regular truck for other duties.

Underground Delivery

Where mine cars are employed to haul coal, the same track is used for delivery of supplies—perhaps to the face or, if trackless mining is the rule, to the point where the rails end. Even with belt haulage, convenience in handling supplies and men has led a number of operators to put supply tracks alongside the belt conveyor—or in a parallel heading. Battery locomotives may be equipped for pulling the equipment on such auxiliary track systems to avoid having to put up trolley wire. And in some instances, rubber-tired tractors and trailers are employed to take in supplies, eliminating track completely. With either system, the added convenience and saving in time and labor is held to warrant the installation of the track or the preparation of the special roadway for the trackless battery units.

Where belts are installed for haulage, especially single panel units, they may be provided with reversing facilities for movement of supplies back to the face. In some instances, at least, special inching and jogging controls have been provided to facilitate handling long cross-bars and other items without hazard to men or to the belt and conveyor.

Facilities for delivering supplies to the faces of rooms equipped with conveyors include:

1. Dolly trucks running in shaker lines.
2. False pan lines, or lines of pans alongside the operating line, which are loaded with supplies and pulled up as the main line is extended, the face pan going into the operating line and the supplies to other face operations. At the same time, a new pan is added at the outby end and loaded with supplies until the place is halfway up, at which point the loaded line will complete the place.

In pitching places small hoists may be included in the equipment at the face to pull timber and other materials up from the track on the gangway below.

MOBILE UNITS—For the most part, unless pitch or some other condition prohibits, the mobile unit operating either on or off the track is the most efficient and flexible unit for supply delivery. In trackless areas, the mobile unit may be a shuttle car, though using a shuttle car on the working shift may result in interference with production. If supplies are delivered on the off-shift, the shuttle car may well double in brass. And if crawler trucks are used for moving shortwalls, these same trucks may also be employed for handling heavy units, such as motors, drives and the like. Special crawler-mounted pullers and carriers also have been built for moving drives and handling materials.

The extra advantages of special equipment, including availability at all times, design for handling materials and the like, have led, among other things, to a substantial growth in such equipment as battery powered tractor-trailer units, especially in trackless areas. Some mines also have used the equivalent of a straight truck with a battery for power.

For rail delivery, the mine car, as noted, still is the mainstay. However, special cars and trucks provide a number of advantages, including better design for loading, unloading and protection of materials and supplies. An example is the low-height flat-bed car with steel deck and holes all around for stakes which lends itself to handling almost any shape or size or material or part. Such cars are used on moderate-pitch slopes as well as on the flat. In tandem and properly loaded, such cars also can move rails and long timbers, though the special rail truck still is a standard item at most operations.

Other special cars which a number of operations have found advantageous include the following:

1. A utility car with a cab for the snapper equipped with plastic windows, and compartments for such items as steel ties, miscellaneous track and trolley supplies, coal augers, roof bolts and the like.

2. Sand cars especially designed for the service, including sides low enough for easy unloading to sand boxes.

3. Enclosed powder cars with sliding doors and insulated couplers.

4. Special insulated detonator cars with steel doors, wood and rubber lining and compartmented drawers.

5. Special ballast cars with bottom doors designed for spreading ballast in the track.

Special handling facilities at unloading or transfer stations underground can materially speed up the job and reduce the hazards. Oil drums, for example, may be lifted off trucks or out of cars by a small chain hoist and run back into the underground depot on a monorail. Similar facilities also may be installed for handling timber, roof bolts and other bulky, lengthy or heavy materials and parts. Handling is facilitated by bundling or tying the materials, such as, timbers, to make it easier to hook onto them with the hoist. In fact, some companies ask that lumber and certain other materials be bundled and strapped by the supplier to facilitate handling all along the line. Properly designed, underground stations of this type make it easy to unload and store materials until the face equipment is ready, then facilitate reloading for distribution.

Preventing Waste and Loss

Reduce waste and loss of parts and materials by setting up rules and standards and following through.

IN VIEW OF THE COST of materials and supplies these days a carefully considered salvage program can result in major savings. Waste and loss, if not controlled, can play havoc with the supply budget. The operating department can contribute greatly to reducing waste and loss.

Key Factors

There is no particularly easy road to reducing waste and loss in parts and materials, but results can be achieved by, among others, the following methods:

1. **Good Records**—Where supplies go and how much (see "Records and Reports").

2. **Education**—Some companies have found, for example, that a display of certain supply items, each tagged with its cost and accompanied by some pertinent words by the superintendent or foreman, brings home to men the costs involved in loss or carelessness and consequently leads employees to handle mterials and parts more carefully.

3. **Prevention of Machine Abuse**—This is largely a matter of training both operators and supervisors in how abuse results in breakdowns, lost time and an increased cost for parts.

4. **Rated Voltage**—Along with education of operators and supervisors, the rule should be rated voltage at the terminals of all machines, since less than rated voltage inevitably results in an increase in machine breakdowns, with attendant loss of time and increase in parts consumption.

5. **Protection**—Moisture in cement, coal dust in an open container of oil, and a bundle of roof bolts thrown along the rib and covered with loose coal are all examples of loss through failure to protect materials and supplies. The moral is enclosed storage for materials or parts subject to weather or water damage, enclosed containers for lubricants all along the line from receipt to point of use, and specific places for everything in the supply line—for example, special supply delivery points, with cabinets, chests and the like as necessary in every section for receiving and storing parts and materials. Indiscriminate dumping inevitably results in loss.

Salvage

The extent of salvage operations depends upon the value of the part or item in relation to the cost of getting it out and, if necessary, reconditioning it. Expending $2 on labor to recover something worth only $1 in the first place is, of course, out of the question.

Education is a major ingredient in an effective salvage operation. In other words, if men are encouraged to form the habit of picking up anything they see lying around and turning it in to a specific salvage station—on each section, for example—rather than walking by or, even worse, pitching things into the gob without thinking, the company benefits not only by the return of usable parts and materials but also from the scrap value of worn out items. Of course, each foreman should check on loose and misplaced materials constantly.

Certain items lend themselves to the use of organized salvage crews—for example, crossbar and post recovery. Equipped with mobile pulling units involving wire lines, chain slings and winches, such crews can, where safety considerations permit, recover several times their wages in posts and bars—as well as ties, rails and so on. A few mines have even used mine-detector-type equipment to find carbon-dioxide coal-breaking shells, steel ties and like buried in loose coal or gob in working places.





STRONG management backing and effective employer-employee cooperation, symbolized in meeting of safety engineer and mine committee (left), lead to worthwhile achievements in safety year after year. The prize is worth the effort.

Keeping Mining Safer

Starting Points

1. Organize for safety, marshalling all safety skills
2. Train and educate for safety
3. Maintain the plant to eliminate physical hazards
4. Motivate supervisors and workers to improve the record

Follow-Through

Top management must provide the impetus

Operating staff must realize management's real stake in safety

Working force and line supervisors must cooperate to attain maximum safety

Trends in Safety

Research in rock mechanics and predictability of roof quality point to roof-safety gains

Machine design, with emphasis still on safety, will improve immediate-face conditions

Off-the-job safety will be increasingly stressed because of its total psychological effect

Mine design will include provisions for permanent barricades under certain conditions

Where to Find It . . .

Starting Points ..... p 327
Safety Organization ..... p 327
Training and Education ..... p 329
Maintaining the Plant ..... p 329
Keeping Interest Alive ..... p 330

SAFETY is more than an idea—it is a state of mind. It is more than a campaign—it is a crusade. The continuity of effective safety promotion, within a company, a region or the industry, demands the full support of top management and the cooperation of employees. The benefits will be—first and always foremost—the preservation of life and limb, followed by other returns such as higher morale, reduced labor turnover, lower compensation costs and higher efficiency.

The ways and means of achieving maximum safety are similar to those relating to other activities within the industry, particularly the technological pursuits. First, an approach must be made, and this includes defining the present status of safety performance, setting goals for the future and making plans for the attainment of these goals. Then, follow through in the execution of the plans is the day-by-day order of business.

Starting Points

Determine the present status of safety performance, decide what you wish to achieve, then set goals that are not too low.

The steps in planning for improved safety performance are as follows:

- Organize for safety, employing all available skills to the fullest degree and enlisting all interested parties.
- Train and educate for safety, using planned programs for workmen, supervisors and management.
- Maintain the physical features of the mine and its surroundings in the approved manner to eliminate conditions which might lead to injuries.
- Maintain momentum through a continuous program of safety incentives.

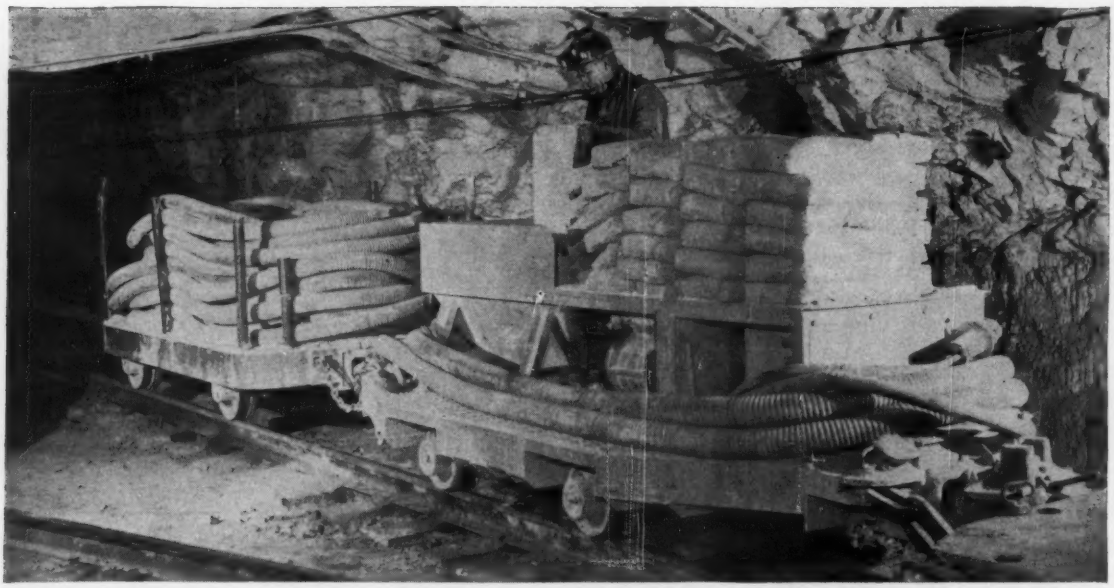
From these starting points the "follow through" should proceed like this:

Safety Organization

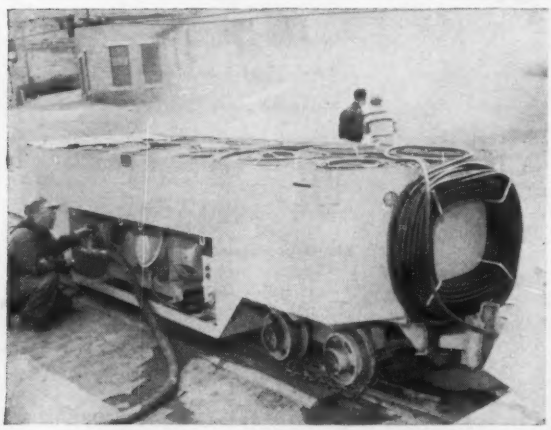
In setting up a workable table of organization make certain all necessary functions are covered by competent people.

Let the safety department concentrate on safety.

The type of organization depends upon the job to be done. Within the company there are a number of functions to be performed. Someone must head up the program, someone must inspect the workings, the ventilation system must be patrolled, training must be conducted, and so on. If the company is small all these responsibilities may be handled by one man. In larger companies op-

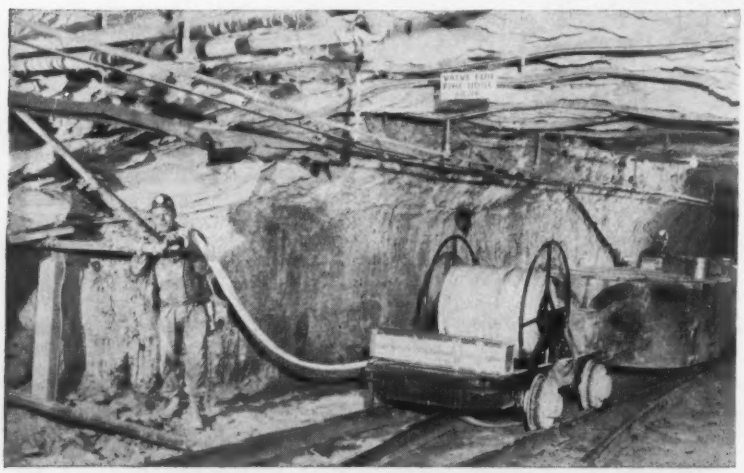


AN ADEQUATE ROCKDUSTING PROGRAM, reinforced with equipment designed for the particular mine, is a long step toward preventing mine explosions—or limiting their spread and damage if an ignition does occur.





PROTECTION against fires, especially at large mines, may include fire trucks which are maintained in a state of readiness. Emergency supplies should be stored in protected caches which are inspected and inventoried at regular intervals.



An ounce of accident prevention is worth a pound of cure

WHERE AMPLE WATER is available under pressure, self-contained fire trucks may be replaced by hose trucks. Locations of "hydrants" should be carefully planned and well marked. One company provides for reversal of flow from main pumps to provide fire-fighting water in working sections.

erating a number of deep and strip mines and cleaning plants the safety department may include one or more qualified men to fulfill each of the functions that must be served.

PROPER STAFF—The important requirement is that some provision be made for handling each function, and this is another top-management exercise in bringing together the skills available within the official family and the jobs to be done. The staff of the company safety department should be neither too large nor too small. An overweighted safety department may become a "dumping ground" for a number of other activities for which a natural home cannot be found in other company departments. The result is a loss of enthusiasm for safety and these losses are doubly difficult to make up.

The understaffed safety department, on the other hand, may miss too many good bets in safety because of difficulty in maintaining proper coverage of its legitimate responsibilities. The best way to get the proper manpower, in quantity and quality, is through sincere top-management consideration of the matter.

EMPLOYEE PARTICIPATING — Employee safety committees should be included in the table of organization. Their recommendations concerning hazards should be heeded and acted upon, their suggestions should be carefully weighed, and their active support in training and promotion ventures should be solicited at the beginning of such ventures.

An excellent example of how such cooperation pays off appears in *Coal Age*, March, 1957, beginning on p 64. The result was that a large mine was able to complete a full year without having a lost-time injury or fatality caused by roof falls.

JOINT ACTION—Above the company level a need may exist for an organization to promote safety for a group of mines or companies having similar safety problems. A full description of an organization of this type appears in the September, 1955, issue of *Coal Age*, beginning on p 58 and featuring the highly successful operations of the Indiana Joint Committee for Coal Mine Safety.

Wholehearted support of local safety associations and institutes by the company and participation of company safety officials in the affairs of Holmes councils and chapters, the National Mine Rescue Association and National Safety Council, for example, are proper extensions of top-management's interest in safety. These, too, represent organizations for safety. Of course, cooperation with federal and state safety and inspection authorities is an integral part of any safety effort.

Training and Education

The terms training and education are not synonymous.

They are two distinct functions, differing in scope and in emphasis.

Safety education is a broad program designed to convince workmen and supervisors of the waste inherent in a high accident rate, and of the real values in high safety performance. Safety training, on the other hand, usually takes the form of a hard-hitting, direct attack on particular hazards, like 100% training in accident prevention. Safety education is a continuous process, while safety training, on any particular subject, begins, proceeds and concludes in a scheduled well-planned manner.

The educational mission can be carried out through the use of a company publication (if thoughtfully prepared), a well-planned poster campaign, word-of-mouth advice and management example. The safety display board near the lamphouse or at the entrance to the property can be a big help here. If it can't be kept timely, however, and if it isn't kept reasonably clean and in good repair, it might better be removed from sight.

TRAINING FUNDAMENTALS — A need for training may be indicated by a general rise in frequency or severity rates. Or the number of injuries chargeable to a single cause — haulage, for example — may spurt upward. Next step is to select the training material, basing the selection upon the recognized needs of those to be trained. If an outside agency is to conduct the training, these instructors and company representatives should meet to examine the content of the course to make certain it fills local needs.

Course material should be severely limited to the interests and needs of the trainees. In a course for cleaning-plant personnel, very little reference need be made to the fact that roof falls and haulage are the major causes of accidents in the industry. They are more concerned with safety on stairs and ladders, and with such other matters as falls of person, open machinery, dust hazards and electric shock.

PROMOTING ATTENDANCE — The problem of getting men to attend the training sessions can be a tough one. The safety committee can be of great help here, if the committee has been consulted early in the planning stages. In striving for 100% attendance at accident-prevention training sessions, conducted by Bureau of Mines instructors, company officials will achieve maximum results by working closely with district officials.

Beyond this basic training area there is advanced training work any company may profitably pursue. Periodic training in advanced first aid and mine rescue may be offered to selected men and supervisors. One important goal of this training should be the development of new instructors.

Training, though, is not an end in itself. The clincher is in management's follow-through, which insures that results match the effort.

Field Reports

Organization—More than a year without a lost-time injury at a big mine results from an integrated safety program. *Coal Age*, May, 1960, p 110.

Photography for Safety—Injury situations are set up for camera to provide hard-hitting safety promotion displays. *Coal Age*, October, 1958, p 124.

Follow Through—Constant accent on safety in daily operations marks operations at the Nation's safest bituminous coal mine. *Coal Age*, August, 1958, p 100.

Designing for Safety—Safety in operations is considered in planning roof support, haulage, ventilation and other elements at a new mine. *Coal Age*, September, 1958, p 92.

Mine Explosions—How they happened, with recommendations to prevent recurrences. *Coal Age*, May, 1957, p 96, and April, 1958, p 30.

Fire Control—Equipment, organization and training are the elements required for effective fire fighting. *Coal Age*, July, 1957, p 66.

Plant Maintenance Serves Safety

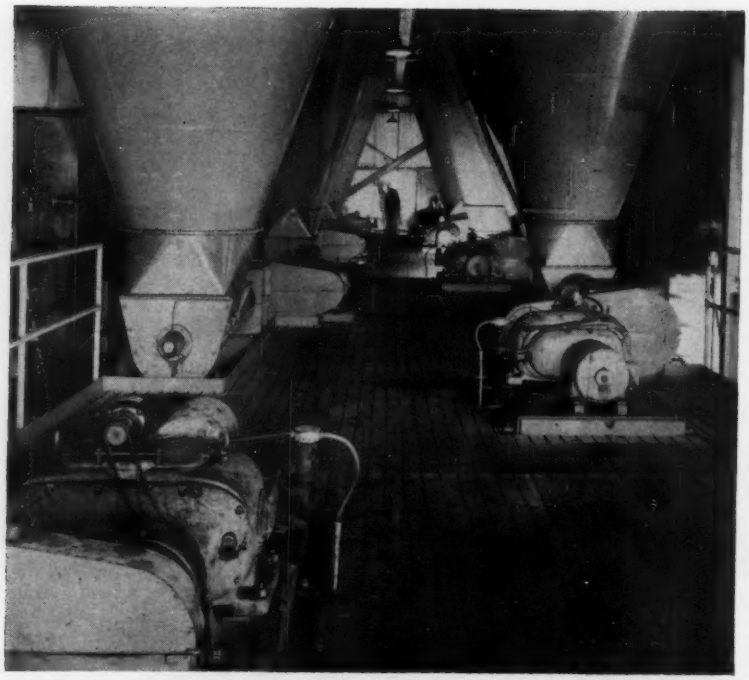
All technical departments have a safety function, since each is responsible for some degree of plant inspection.

Design plant safeguards, such as fire-fighting equipment, in full recognition of the investment in plant and the welfare of personnel.

VIGILANCE is the keyword in maintaining a mine, cleaning plant or strip pit in safe condition. A sluggish track switch in the mine, "soft" brakes on a strip-mine haulage truck, dust accumulations in the preparation plant—all these are examples of potential accidents that can be headed off by good plant maintenance. In this connection, the plant includes all real estate, above and below, and equipment.

The steps through which this safety maintenance is achieved are the old standbys—inspection, reporting, repairing and following through. It is to be noted here that all technical and operating departments have a safety function, inasmuch as each is responsible for some degree of inspection and repairing within its own area.

Some larger companies, employing full-time safety inspectors, have set up hard-and-fast rules on clearing up hazardous conditions. The company safety inspector at the end of his visit leaves at the mine or plant a



GOOD HOUSEKEEPING and adequate machine guards are major provisions for safety of personnel in surface plants. Safety begins at the design board.

list of the hazards and violations of good practice he has found. Copies of this list are filed in the safety department and with the operations chief. Mine officials are required to take appropriate action to remedy the condition, then report their actions through proper channels to the chief of operations. If such a report does not come up within a specified time, the safety department and chief of operations begin to ask questions. The system insures follow-through on safety-department recommendations.

DEEP MINES—The most important elements in maintaining a deep mine in safe condition are roof support, methane control and dust suppression. Falls of roof, rib and face still are the No. 1 killer, although a striking improvement under bolted roof is now in the records. The most promising remedies are closer supervision, strict compliance with timbering standards and bolting patterns, including as much extra support beyond the standard pattern as necessary, and better trimming of overhanging brows and loose coal. These are the only possible solutions to the problem as long as men are needed at the face.

A new development, for increased safety in the immediate face area, is a self-advancing roof shield which may be powered from the hydraulic circuits of a continuous miner.

Efficient ventilation is safe ventilation. Proper methane control demands that sufficient air at reasonable velocity be moved past active faces to dilute and sweep away the gases issuing from the coal. Maintenance of physical plant in the interest of safety demands that bleeders, if they are part of the mining plan, be kept open, that stoppings be sealed against leakage and that airway obstructions be removed. Effective gas detectors also must be considered as safety maintenance tools.

In underground dust suppression the big guns are rock dust and water sprays. The latter may include wetting agents. Recent developments in rock-dusting machinery now permit in-cycle distribution. And the latest development is the application of the air-slide principle to rock-dust handling and application underground. Efficiency is remarkably increased, and labor requirements are reduced.

Goals are not only a good dusting job but also elimination of the dust problem, which can be particularly acute in dusting in cycle behind a continuous miner. Methods and equipment in two mines are outlined in articles in the following issues: *Coal Age*, February, 1955, p 82; January, 1956, p 62. Now in use is a slurry-type rockduster which can be mounted directly on mining machines, and a self-propelled unit.

Whatever the methods, however, the main point is that the rock dust should be evenly distributed, in back headings and returns as well as in more active places. Rock-dust barriers may be included in the overall plan, and the importance of loading out excessive accumulations of coal dust should not be overlooked.

Knocking dust down as it is made by water sprays takes on added importance not only as a means of reducing the explosion hazard but also because of the increased disposition on the part of compensation commissions to grant awards for purported lung damage, even though coal dust still is to be proven as the culprit.

In all instances, maintenance of a safe plant requires the establishment of fire-fighting systems, including water lines, tested firehoses and chemical extinguishers, where needed. There is great value also in developing efficient fire-fighting organizations with assigned duties for key people. One company has conducted underground fire drills, using smoke bombs to focus the situation in order to train workmen in the actions they should take.

New developments should be given full consideration in fire-prevention and fire-fighting programs. One manufacturer reportedly offers a dry, bagged material which is effective against all classes of fires. The chemical is capable of producing carbon dioxide in the presence of fire and does not deteriorate upon standing. Also important is the foam-plug method of fighting fires now being studied and refined by the Bureau of Mines and manufacturers.

STRIPPING—In stripping, safety maintenance is primarily a matter of equipment maintenance. A schedule for wirerope changes should be worked out, since each unexpected rope failure is a potential accident. Haulage trucks must be kept in good condition to head off steering and brake failures particularly. Well drained smooth-surfaces roads may eliminate dangerous skids, and in dry weather road surfaces should be sprinkled.

Truck spotters must be properly trained to stay out of the way of backing trucks and out of close clearances around dump ramps. They should also be competent in keeping drivers out of trouble.

PREPARATION— In preparation plants, particular check points for safety inspectors are dust accumulations on beams, housekeeping in the oil-storage area, cleanup precautions before any welding is done, open gearing, exposed wiring, overhead obstructions and so on.

The possibility of using paints of different colors in the plant might be weighed. For example, standard colors for safety include red for fire exit signs and fire equipment; orange on the inside of movable machinery guards and exposed edges of pulleys, gears, rollers and so on; yellow for handrails, top and bottom steps and caution signs; green for first-aid equipment; and black and white for traffic lanes and direction signs.

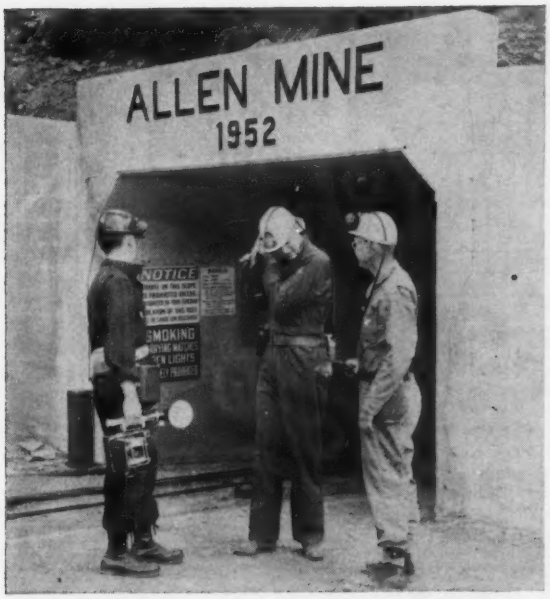
One final requirement if all this maintenance is to be meaningful, is that workmen wear proper articles of protective clothing and refrain from wearing loose clothing.

Keeping Interest Alive

Don't go too long with an incentive that is not doing a job. Cancel it or change it.

ILL-ADVISED INCENTIVES may not set back the cause of safety but they can be a waste of time for the safety department. A decision to adopt or reject a proposed incentive must be based upon thorough study, with local conditions and personalities weighing heavily in the final judging.

Strange as it may seem, safety bonuses for supervisors have not been an unqualified success in all quarters. The privilege of wearing a white safety hat for supervising a crew through an accident-free month may





SAFETY DIRECTOR and company photographers prepare to go underground to reconstruct a recent accident. Photo at right shows safety director and shuttle-car operator setting the scene to record on film an effective safety-promotion display.

be more exciting. And even more worthwhile is some scheme where everyone participates in making a good record and shares in the acclaim.

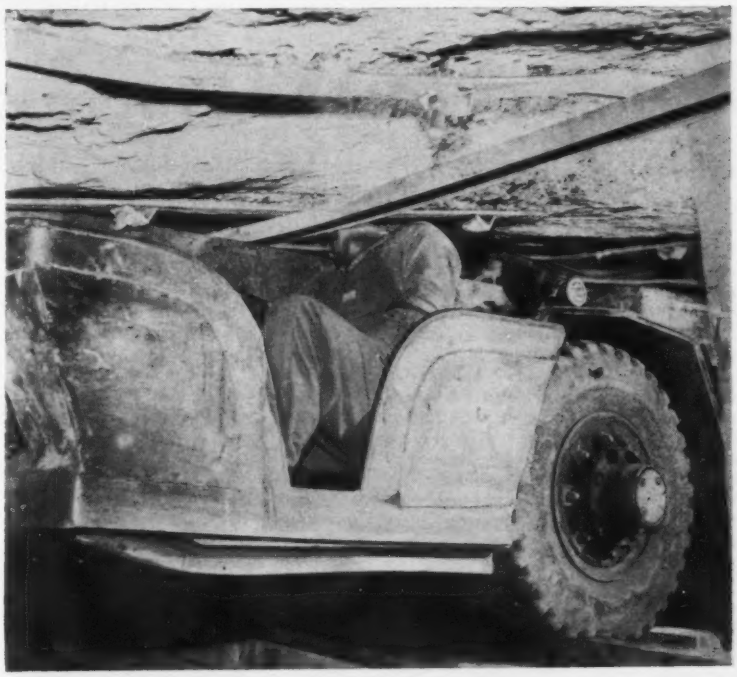
Slogan contests are effective attention getters, if properly conducted. Application blanks may be distributed as payroll inserts. The response will be gratifying if the prize is worthwhile. Then interest and participation in the next contest will be assured if the winning slogan is widely promoted.

Once an incentive has been adopted it must be given a fair chance to succeed. But if it still fails to have the desired effect in creating enthusiasm or reducing injury rates, it must be summarily discarded. Permitting such an incentive to drag on with only half-hearted promotion may be mighty damaging to the entire safety program. Best practice in a situation like this is to have another idea ready to take the place of the incentive you must scrap, although the new idea should be one that has a better-than-even chance of success.

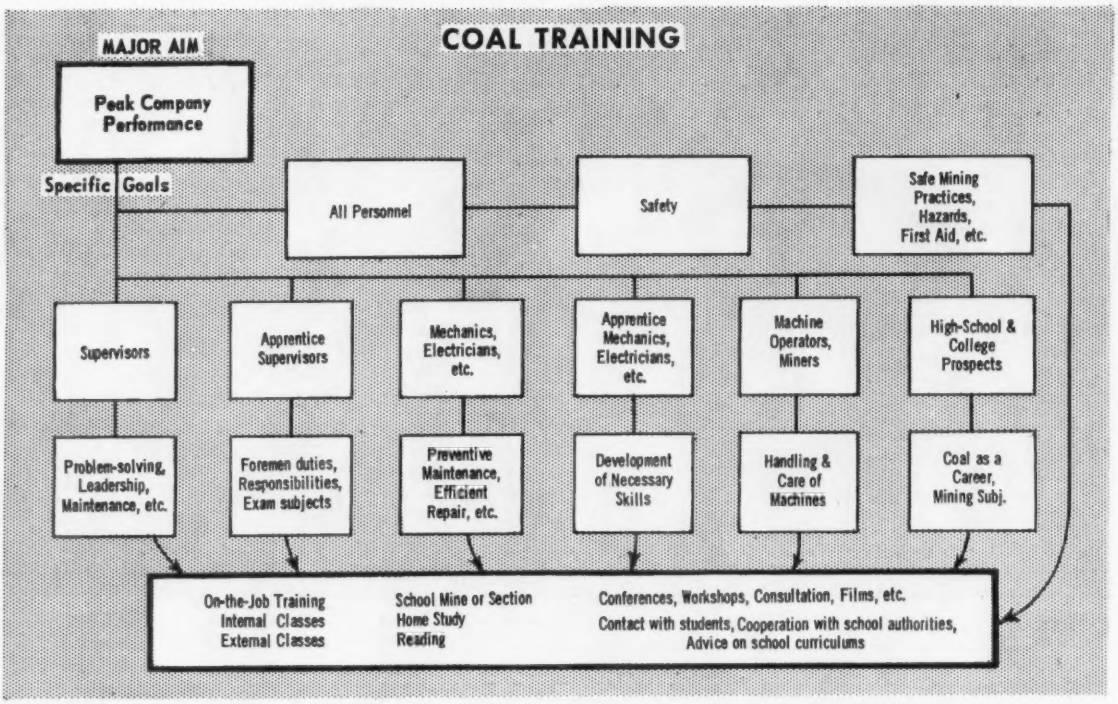
FOLLOW-UP TRAINING—Timely scheduling of refresher training sessions is another way of keeping safety interest at a high level. The accident-prevention training offered by the Bureau of Mines is practically a "must" at all mines because it has captured the interest of the men at mines where it has been given already. Follow-up sessions on this type of training are especially recommended to insure that maximum longtime benefits accrue.

One of the best ways to keep the safety program alive is to look for opportunities to reward individual achievements in safety. The recipients will be happy to have their achievements recognized, and the others will have their interest aroused. Notable individual safety records can be searched out at virtually every mine.

Recent reports from several sectors point up the opportunities to which management should be alert. In one instance, a unit foreman led his crew to the safety of a barricaded position following a disastrous explosion. All were rescued after several hours. In another case, a workman was lowered in a make-shift cage to the bottom of a blast-damaged shaft as the exploratory first step in a recent recovery operation. Subsequent work was based on his exploration. These men were properly honored. Such achievement should not be overlooked. On the other hand, day-by-day attention to safety which results in a commendable record of accident-free performance should be recognized. The cause of safety will be better served if this recognition is forthcoming.



THIS SAFETY-PROMOTION photo, resulting from stage-setting in scenes above, dramatizes accident causes. It will be posted and published in house organ.



Training: Vital to Progress

Why It Is Vital

OVERALL GOAL of training is to achieve peak performance of the total operating force—both management and men. Peak company performance is vital to getting maximum returns from higher investments in manpower and equipment, and, in turn, to keeping costs down and holding market advantages over competitive fuels.

Training is also vital to developing a greater supply of skilled talent for tomorrow's higher tonnage output. Predicted shifts in the makeup of the operating force show that a major drop in the number of production men will be accompanied by an equivalent increase in the total of certain highly skilled categories—supervisors, engineers, and maintenance, general-inside and preparation men.

How to Train

Use methods best suited to miner training needs.

Give supervisory personnel opportunities to improve their knowledge and skills.

HOW MINERS and management personnel are trained depends generally on company training philosophy, the number to be trained, the type of training and who is to be trained. Those methods generally employed, or most desirable, for training miners include the following:

1. On-the-job mine or shop training. At least some exposure to this type of training is virtually indispensable for apprentice supervisors, apprentice mechanics and electricians.

2. Classroom instruction and extension courses. Where only one, two or a few men are involved, the mining school extension course is frequently the best expedient.

3. Combined classroom instruction and on-the-job training. Some companies find that textbook learning must be accompanied with practical experience for best results.

4. A school mine or section serving a field or a group of company mines. This method is specially good for training new employees, transfers, etc.

For training supervisors and managers, the following techniques are considered good practice:

1. Regular conferences and meetings, including reports from standing or special committees. Free discussion of problems and other matters of mutual interest open the way to increasing the individual supervisor's or manager's knowledge and skill.

2. Formal instruction courses. These may be presented in strictly textbook and/or discussion form, or can be accompanied by laboratory work.

3. Home study and reading. Keeping abreast of current developments in the industry and of good mining practices as, for example, through regular reading of *Coal Age* is an avenue of learning dependent only on the individual's initiative.

Who to Train

Check over the entire production force to determine what types of training are needed.

Consider the value of training for both specific and general occupational needs.

IN EVALUATING training needs, a company considers giving the following types of instruction to the following groups:

1. All company personnel—General safety training. This can help greatly to increase individual safety consciousness and to promote safe mining practices. Certain personnel, furthermore, might receive specialized instruction to suit occupational needs. The underground man, for example, has the greatest need for detailed information on the dangers of inadequate roof support. Similarly, the tippleman needs special coaching on the hazards of preparation plant machinery and equipment.

2. Mechanics and electricians—Instruction in preventive maintenance procedures, how to spot equipment troubles quickly, and how to make repairs efficiently.

3. Machine operators and selected alternates—Training in how to handle and care for their machines to ensure maximum performance in the production cycle.

4. Apprentice supervisors—Instruction in the foreman's duties and responsibilities, and in all mining subjects he must know to certify for foreman's papers. Trainees should be carefully selected for leadership qualities.

5. Apprentice mechanics, electricians and shop workers—Training in the reconditioning and rebuilding of equipment. Recruits can be drawn from company ranks or from outside sources.

6. Supervisors and managers—General instruction in how to be better bosses, and

Where to Find It . . .

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On-the-job . . . Classroom . . . School mines . . . Meetings . . . Home study

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On-the-job . . . Manufacturers' instruction . . . Surface course . . . School mines

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special instruction in how to increase their knowledge and skills in certain areas of responsibility. Foremen well trained in spotting equipment troubles and in good preventive maintenance, for example, can contribute much to minimizing downtime.

Training Foremen

Seek to develop new supervisors from the ranks through a program combining classroom instruction and practical experience.

Improve the performance of foremen on the job by giving them regular opportunities to discuss their problems with other foremen and superintendents.

THE TRAINING of foremen usually breaks down into two main parts: training experienced foremen to do a better job, and training men from the ranks on the foreman's duties and responsibilities.

DEVELOPING NEW FOREMEN — "Imports" of good foremen are becoming scarcer and, furthermore, experience shows that this method is not a reliable means for procuring topnotch career men. Perhaps the best bet for adding to the supply of quality foremen is by upgrading men from the ranks through a combined process of classroom instruction and on-the-job training.

A number of variations of this technique may be employed, especially as these variations deal with the relative amount of time devoted to classroom work and to on-the-job training. One company figures on a 3-mo course which dovetails 600 hr of on-the-job visual education with 75 hr of textbook learning, discussion and home study.

By rotating foremen trainees for 2-wk stretches of on-the-job training in six different mines over a 3-mo period, each man is able to (1) gain first-hand knowledge of a wide variety of seam conditions and mining systems and (2) observe 30 to 40 different foremen on duty. In this way trainees can see for themselves what makes a really good foreman tick. Comparisons are readily made, for example, as to which foremen get the best response from their men and which take the most pains in good housekeeping. Perhaps most important, trainees note:

1. That the mine or section foreman is the key to high productivity.
2. That the foreman's attitude—whether aggressive or lackadaisical — is reflected throughout the ranks of his men.
3. That many mining problems stem from lack of understanding between the foreman and his men.
4. That a good foreman must be able not only to handle men but also to get along with them.
5. That to be successful, a foreman must be a true leader—not only well-informed on the art of mining, but also well-versed in the limits of his authority, and well-practiced in how to be fair and when to be firm to all his men.

On-the-job training should be supplemented with at least 1 hr of classroom instruction per day. It may be necessary to set up two classes to accommodate both day and night shifts. Instruction, given by company or outside experts, or both, should cover all subjects basic to foreman certification. A full curriculum, for example, might include ventilation, gases, approvals and permits, records, general mining practices, explosives, belts and conveyors, electricity, first aid, roof-bolting, general safety, lamp assembly, gas testing and anemometer use. Special instruction on the super isor's duties, on company standards, and on the importance of human relations in job performance is highly desirable.

Textbook instruction can be based on the state mine foreman's guide (if one is available), or on publications of state mining departments and extension services of mining schools. Such material is usually most effective if adapted and simplified by company instructors.

UPGRADING EXPERIENCED FOREMEN—Foremen on the job can get valuable training through conference discussion of their problems with other foremen and with superintendents. The conference method brings collective experience to bear on current problems and permits valuable exchange of know-how and ideas.

One of the best ways of implementing this technique is through regular meetings at the mines. Foremen meet with their

Success Keys

1. Define the objectives of training and make these publicly known to the maximum number of eligible participants.
2. Conduct a careful screening of candidates for new jobs and higher-ranking jobs. Screening techniques include personal interviews, application forms, personal references, aptitude tests, etc.
3. Organize and outline the training, using instructors who are not only well-versed in their subjects but also capable in the art of communication.
4. Provide adequate, comfortable facilities for classroom instruction, where included in a training program, as well as authoritative textbook material and illustrative training aids.
5. Create a training environment that will encourage employee participation. Salaries for working personnel, for example, should not suffer; transportation problems should be worked out.
6. Arrange for periodic follow-up of trainee performance on the job and make refresher courses available to those who want to brush up.

Practice Trends

Foremen—Emphasis centers on developing new staff from the ranks. Existing staff gets special courses in supervisory, mining and maintenance skills.

Mechanics and Electricians—Growing needs being met by more classroom and on-the-job training.

Machine Operators—Training stresses proper handling and care of machines. A future possibility: School mines or sections for an area or group of mines.

New Recruits—Attention focuses on high schools and vocational institutions to develop engineers, miners and supervisors.

Field Reports

Test personnel—Psychological tests have proved practical in measuring employee ability and personality. Correctly used, they can be a real asset in upgrading personnel selection and placement. *Coal Age,* September, 1957, p 70.

Recruiting Youth—Industry, schools and parents in the Bluefield (W. Va.) area cooperate to whet youthful appetites for careers in engineering and vocational trades. Program activities are directed toward public relations, science fairs, engineer speakers, guidance, and school problems. *Coal Age,* November 1957, p 54.

Troubleshooting—Classroom and laboratory training aim to develop competent men in electric troubleshooting and maintenance. A basic course covers electrical circuits, contractors and relays. DC motosr, and wiring diagrams. Qualified men move to advanced training in hydraulics. *Coal Age,* December, 1957, p 72.

Shop Training—An 18-mo shop training program for new recruits provides a reserve of potential maintenance men. Interest of older workers is increased through a 60-hr course in basic electricity. The payoff: Less downtime. *Coal Age,* January, 1958, p 110.

Mine Maintenance—The Winding Gulf Operators Association and the Raleigh County Vocational School, Beckley, W. Va., cooperate on a training program to educate field maintenance men. The aims are to relieve the area's personnel shortage and build up a reserve of skilled electricians, mechanics and shop men for the future. *Coal Age,* December, 1958, p 90.

Management Workshops—Penn State Mineral Industries Extension Services pioneer in a series of five-day workshops planned exclusively for coal. Programs are beamed to all levels of management, from foreman to president. No geographical limits are placed on participating companies. *Coal Age,* June, 1959, p 76.

superintendent in his office, or some other suitable place, for 1 or 2 hr. The meetings can be arranged so that each foreman from each shift manages to attend one conference of every two or three.

At these sessions, the freest possible discussion is encouraged—no holds are barred. In this way, many opportunities are provided for practical schooling not only in operating and labor questions but in mine mathematics, physics and chemistry. Sometimes, foremen are asked to prepare a "laundry list" which promotes discussion on such problems as:

1. How to instill the spirit of cooperation among employees.
2. How to eliminate absenteeism.
3. How to minimize carelessness and "goldbricking."
4. How to recognize desirable characteristics in a satisfactory foreman.

The conference method also finds expression through division- or company-wide meetings. Foremen are taken off the job for 5-day periods and meet in some central geographical spot to participate in an organized conference agenda. Here, the aims are usually broader in scope than at mine meetings. Company activities and policies are discussed and practical help is given in leadership, employee and community relations, efficient conduct of safety, maintenance, production work and product control. An opportunity is provided to meet and get acquainted with top company officials. The program also includes relaxation and entertainment.

For formal instruction to foremen, consider the possibility of giving night classes from September to May. Classes might meet two nights a week from 8 to 10 P.M. Subjects covered could include mine engineering and mathematics, public speaking, better reports, techniques of job instruction and conference leadership.

Men from these classes might then be selected for an intensive 2-wk summer course, meeting 6 days a week from 8:30 AM to 4 PM. Successive groups could be selected between June and early September. While they are going to school, foremen should be paid their regular salaries and no charge should be made against vacation time.

Maintenance Training

Investigate the possibilities of in-company training to enlarge and improve the existing force.

Consider how supervisor training can aid in reducing maintenance costs.

IMPROVING THE EXISTING FORCE—Modern practice points to in-company training, based on combined classroom instruction and practical experience, as the best way to upgrade the quality of the existing maintenance staff.

One company, for example, sets up a definite course of instruction, on company time, for an initial group of 18 mechanics in three classes of six men each (**Coal Age,** April, 1957, p 76). Each of the three classes meets twice a week from 8 AM to 11 AM, in a specially equipped classroom near the surface shop. The course is designed to provide a minimum of 48 hr of instruction and practical exercises in electrical theory and trouble-shooting. Before the program is completed, 36 other mechanics have an opportunity to take the training.

Purpose of the training program is to provide means through which the men presently employed as section and shop mechanics can upgrade themselves to handle the problems of modern machine mining more efficiently. In developing this program, management was inspired by these two facts:

1. Good preventive maintenance and the fastest-possible location and clearance of electrical troubles are absolute necessities.
2. No one can criticize the work of a mechanic if he is not equipped with the proper tools and the training he needs to adequately maintain today's mining machines.

With such considerations in mind, operating officials and maintenance men met to discuss ways and means of improving maintenance. The outgrowth of these meetings was a formal instruction program, sponsored by the extension services of one.

Instruction begins with a review of the fundamentals of electricity, including the relationships in Ohm's law, characteristics of series and parallel circuits, and the proper use of meters and instruments. Basic principles of motor operation and the functions of relays and contactors are thoroughly treated, using actual machine components as instructional aids.

The aim of this instruction in fundamentals is to draw together on common ground the six men in each class, who most likely have diverse aptitudes and experience. From this point, the emphasis is on troubleshooting.

Several concessions are made by the company, and by other mechanics not yet in training. The company agrees to have the men attend the school two days a week for the specified hours and then to complete these shifts on their assigned jobs. This means that, while men are enrolled in the course they must work steady dayshift during the instruction period. The other mechanics, who enter training later rotate on the second and third shifts to make this schedule possible.

Benefits of the program indicate that maintenance will be improved through increased job knowledge and job interest among the maintenance men. Reductions in downtime, resulting from faster clearance of outages, are expected to return the investment in training within a reasonable period of time. And a valuable by-product of the training may be the discovery of unrealized leadership talent among the maintenance men.

RECRUITING NEW STAFF—More frequently than not, the announcement of

shop training for apprentices brings a deluge of applications, considerably in excess of job quota needs. Thus, one of the biggest jobs in adding new maintenance men is in the selection of trainees.

Initial screening is usually based on personal interviews with operating and maintenance officials. For further screening, aptitude tests may be employed to determine more scientifically a candidate's intelligence, knowledge and fitness for mechanical or electrical work.

In one 18-mo shop training program, trainees are put to work in the central shop, primarily on the rebuilding and reconditioning of equipment. They work with experienced mechanics and electricians, covering all phases of maintenance work, from the dismantling of equipment to final assembly and testing.

Along with practical shop work, lecture and classroom study is provided. This part of the training program is conducted in a central repair shop classroom which is equipped with a lecture and demonstration table, a large blackboard, and an opaque projector and screen. Through the use of these facilities, the basic fundamentals of lubrication, hydraulics, mechanics, and electricity are explained and illustrated. A special effort is made to have the lecture material coincide with shop work. To round off the program, representatives of various manufacturing companies give lectures on the construction and care of machines.

A shop training program of 18-mo duration naturally involves a great deal of instruction time. This may become quite a problem as the need increases for adding more new mechanics, electricians, etc., to the staff. One solution here is to start new trainees on a staggered system.

SUPERVISOR TRAINING—Substantial savings in production time and maintenance costs can be achieved if foremen have a better appreciation of the care of mining equipment. Such appreciation can be best achieved by showing them how to sport equipment trouble before a major breakdown occurs. A company should expect foremen to take instruction as an opportunity to learn and become more valuable employees.

A typical course might include instruction in the fundamentals of electricity. Such topics could be covered as Ohm's law, wiring and magnetism, AC and DC principles, DC mine circuits and Lenz's law. With this as a foundation, foreman students could pass to applied maintenance procedures—for example, how to read schematic wiring diagrams, and how to trace and isolate trouble in one part of a circuit and then check items in that section.

The benefits of foremen's maintenance training are not always measurable in dollars and cents. They are reflected in other ways. There is better cooperation between foremen and mechanics. Major breakdowns are prevented since equipment is stopped and repaired before it fails completely. When a failure does take place, there is less downtime because the foreman and mechanic work with the wiring diagram and all effort is directed to fixing the machine rather than to "shooting in the dark." A frequent result is that fewer new parts have to be purchased. Although not easily measurable, benefits add up to more production per shift.

Training Machine Operators

Consider training in the proper care and handling of machines as a basic factor in achieving maximum mine output.

Explore the possibilities of setting up a school mine or section to provide practical experience in the operation of machinery and equipment.

MINERS REQUIRE a great deal of skill to get top performance from modern coalmining machines. Thus, adequate training in the handling of continuous miners, shuttle cars, cutting, loading and drilling machines, timbering and roof-bolting machines, etc., becomes a key factor in achieving maximum mine output. Through the proper handling of machines, the operator also plays an important part in preventing abnormal wear and tear which lead to breakdowns and lost production time.

In most cases, machine operators learn their jobs through on-the-job training as helpers to experienced men. Some of the largest machine manufacturers conduct instruction programs on machine operation for customers. Where such training is available, companies should take advantage of it, especially when shifting from conventional to continuous mining machines.

At least one company has found it beneficial to duplicate the turns an operator must make underground. Trainees then practice for 6 or 8 hr periods under the supervision of the mine superintendent or safety director. As a result, machine maneuvering skills are improved and fewer timbers are knocked out.

SCHOOL MINES—A small training mine or section—serving a field or a group of company mines—is an excellent way to provide practical schooling in machinery operation.

This technique would be particularly helpful in training new employees, transfers, etc. It also may help to cut down the cost of training. Coal produced in the training mine can be marketed, like any other coal, through the sponsoring company or association. With an experienced foreman and one or two experienced assistants, the cost of such coal might not be too much higher than coal from a regular working section. And once on their regular assignments their production and safety performance should result in lowest cost.

Safety Training

Aim to give all company personnel a better understanding of their safety responsibilities to themselves and to their coworkers.

Provide thorough training in the proper handling of machinery, equipment and tools, and in actual and potential hazards.

BETTER MINE engineering will continue as a basic attack in the industry's battle to reduce accidents and fatalities. Equally important, however, is attack on the most stubborn of all obstacles—the foibles of human nature. When every individual realizes more completely his safety responsibilities to himself and his co-workers the stalemate, in all probability, will break. And better individual understanding means primarily one thing: more intensive and extensive safety training and education.

Basic to safety training are the following guideposts:

1. **Safety training** should be given to all personnel, from the manager in the office right down the line to the man at the face.
2. **Unrelenting effort** should be made by all personnel to observe safe mining practices and to comply with safety laws and regulations.
3. **Good housekeeping** should be practiced at all times—carelessness and messiness are the harbingers of accidents.
4. **Thorough training** should be provided in the proper handling of machinery, equipment and tools.
5. **All personnel should be thoroughly indoctrinated** in the actual and potential hazards of their occupations, and properly equipped with safety gear when necessary.
6. **Horseplay and taking chances** should be outlawed.
7. **More emphasis should be placed on getting cooperation** in good safety practice than on inflicting penalties for breach of good practice.

It is difficult to document what individual companies should do to carry out a vigorous campaign of safety training and education since, in each case, methods should be suited to particular needs. But a number of general practices have evolved which have proven their worth, or have received fairly widespread acceptance. These include:

1. **Setting up a committee** to promote the cause of observing safety laws and regulations and to act as liaison between management and labor on grievances.
2. **Posting bulletins, cartoons and other billboard data** at strategic points to arouse safety consciousness on the job.
3. **Instructing foremen to organize weekly meetings** between themselves and their crews for the discussion of current safety problems.
4. **Arranging for USBM** instructors to give their 100% accident prevention training course to all personnel.
5. **Providing instruction** in first-aid and mine-rescue work.
6. **Participating** in safety contests.
7. **Promoting attendance at Holmes** safety chapter meetings.

Pre-employment Training

Expand existing recruitment and publicity programs.

Concentrate on high schools for long-range development of new talent.

ESSENTIALLY, selling the coal profession to young men involves improving and expanding existing pre-employment and training programs.

Excellent publicity material has been prepared for all levels of students by the Na-

tional Coal Association, other coal associations and some companies. Mailings of such material, however, are dwarfed in comparison to educational programs carried on by other industries.

One of the most promising developments on the recruitment scene is increasing management recognition of the importance of interesting high-school students in coal-mining careers. More and more personnel managers are realizing that the high-school student, particularly in coal mining areas, is the key to long-range fulfillment of personnel needs. However, although a handful of companies are conducting aggressive high school campaigns, only the surface of opportunity has been scratched.

ENGINEERING RECRUITMENT — Some 200 scholarships in mining engineering are offered throughout the country by coal associations and individual companies. But this number is certainly not adequate when compared to the industry's immediate needs for engineers mentioned above. It becomes even less adequate in view of reports that many existing scholarships go unclaimed.

Much could be done to alleviate the scholarship situation by more widespread advertising of scholarships, by sending company and association representatives to recruiting areas to sell the modern coal profession to prospects, and by setting up salary scales and living conditions commensurate with standards in most other professions and industries.

When scholarships are awarded for college study, it is frequently desirable to pin the grantee down to a formal contract. By this contract, the company agrees to pay, say, $1,000 per yr for 4 yr of college education. In return, the grantee agrees to work for the sponsoring company for at least 2 yr after graduation.

Salaries offered sometimes can not be as good as those offered by some other industries. But the differential, where occurring, is made up through the benefits of the 4-yr scholarship. Also, by having the grantee agree to work for at least 2 yr with the company, he is brought to the point where he can take the mine foreman's exam, thus qualifying for higher pay. At least one company has had outstanding success in holding grantees by this system.

MINER RECRUITMENT—Engineers are one industry need, but miners, mechanics, electricians and bosses are equally critical now and in the future. A well-thought-out and well-carried-out program also serves to build the interest which will make recruitment in these categories more rewarding among high-school and junior high-school students.

There are a number of approaches to developing and holding the interest of such students. A typical approach, however, might capture the interest of boys and their parents in the modern coal mining profession through sponsoring science fairs, movies and lectures about coal and inspection trips to mines. These efforts might be accompanied by offering aid to organize high school mining curricula and to set up vocational guidance committees. It might also prove expedient to subsidize, or otherwise provide, necessary teaching and guidance talent.

High-school mining courses are generally designed for 3 yr and school time is divided between traditional academic subjects and vocational subjects, with careful correlation to insure that boys will become good citizens as well as good miners. A typical course might be made up as follows:

Sophomore Year, Mining Subjects—Geology of coal, mine law, mine gases, ventilation, timbering. **Shop work** — Welding, bench work, lathe, drill, shaper.

Junior Year, Mining Subjects — Tracks and transportation, ventilation, drainage, pumps and pumping, related mathematics. **Shop Work** — Electrical circuits and diagrams, motors and controls, resistances, testing equipment.

Senior Year, Mining Subjects—Explosives and blasting, ventilation, mine law, mapping and drawing, mine chemistry, applied trigonometry. **Shop work**—Hydraulics, general mechanics (clutch, transmission, gears, power), timbering, tracklaying.

All Three Years—Academic Subjects: English, social studies, physical education.

Teachers forming courses like the above are, for the most part, experienced coal mining men. Realizing that teachers with coal mining experience are essential but scarce, coal operators and associations can cooperate to seek out properly qualified men for teaching jobs.

Help in Buying . . .

A COMPLETE CROSS SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in the following pages to round out this 1960 Mining Guidebook issue of *Coal Age*.

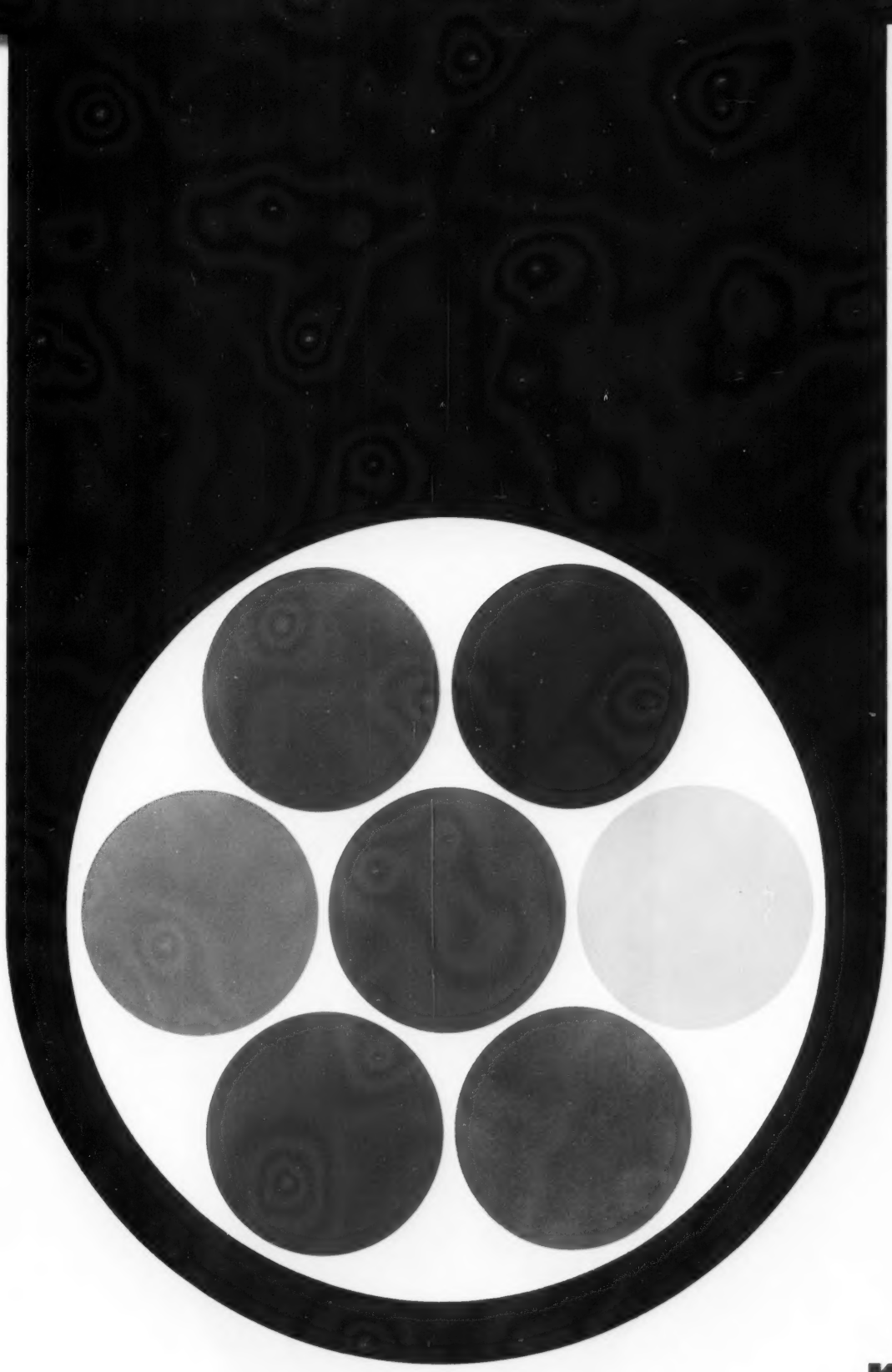
1. If you need equipment, materials and services not previously used . . .

2. If you are interested in additional sources of equipment, materials and services . . .

3. If you are developing a new idea in production, preparation and safety and want to see what's available for carrying it out . . .

Check the Buying Directory beginning on p 341 of this issue. Find the product in the alphabetical list. Under it will appear the names of the key manufacturers, with those advertising in this issue indicated by black-faced type. Trade names also are included in the Buying Directory for convenience in identifying and selecting products.

Consult advertisements in this issue for information on specific products.



IN ELECTRICAL WIRE & CABLE . . . **THE SPARK OF QUALITY IS KAISER WIRE EXPERIENCE**

K/W PORTABLE CABLE... MORE DRAG MILES IN TOUGH COAL MINE DUTY

KAISER PORTABLE CABLES—now available in more than 300 types/designs/sizes—offer superior resistance to tearing, impact, or breakage in every price range.

For example, Kaiser Kalzone Insulation—a Butyl insulation for service over 2000 volts—surpasses ASTM D-1352 requirements for strength by 41 per cent... elongation by 83 per cent. Kaiser 60 Per Cent Neoprene Jacketing Spec. 14-S surpasses ASTM D-752 strength by 72 per cent... elongation by 100 per cent. Completed cables receive additional superiority from K/W design and construction methods.

Kaiser Portable Cables are approved for listing by Pennsylvania Department of Mines and Federal Bureau of Mines.

The result: In rough duty—shuttle buggies, cutters, loaders, shovels—K/W cable can mean as much as five times as many drag miles per cable... fewer splices or delays... more production from each piece of equipment.

FOR IMMEDIATE INFORMATION ABOUT KAISER PORTABLE CABLES MADE ESPECIALLY FOR UNDERGROUND AND STRIP MINING, CALL YOUR K/W DISTRIBUTOR OR WRITE KAISER ALUMINUM & CHEMICAL SALES, INC., KAISER CENTER, 300 LAKESIDE DRIVE, OAKLAND 12, CALIFORNIA.



IN ELECTRICAL WIRE & CABLE
THE SPARK OF QUALITY IS K/W EXPERIENCE

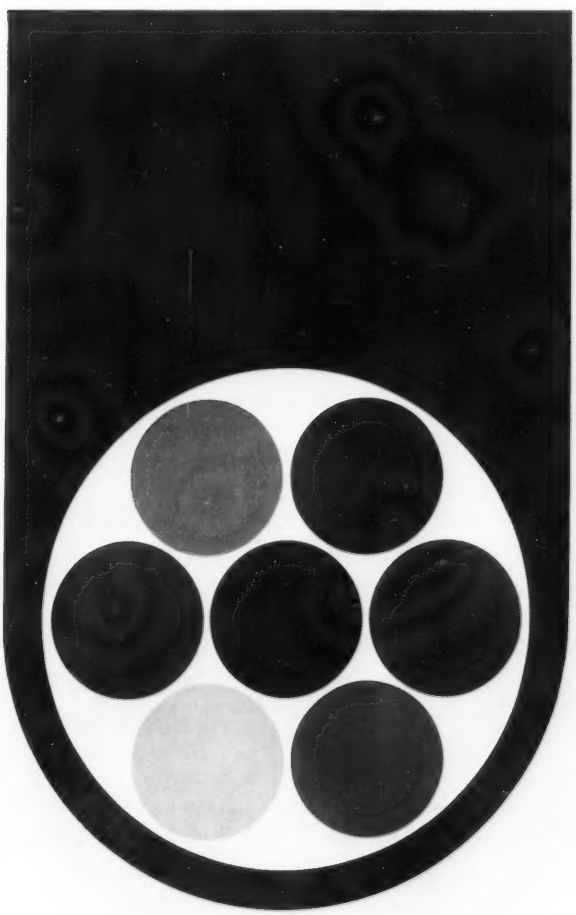
The spark of quality means positive—often dramatic—savings in service for mines who will specify Kaiser Portable Cable.

For among the world's leading electrical wire and cable producers, only Kaiser is heir to the 70-year experience of a major rubber company in developing insulation and jacketing compounds.

Over the years this special background and experience has created a wide choice of Kaiser Portable Cables that consistently deliver extra performance life for every dollar of cost.

Why not use K/W experience to your advantage?

KAISER ALUMINUM



Announcing . . .



THE 1960 EDITION OF

KEYSTONE COAL BUYERS MANUAL

The Most Comprehensive Volume of Authentic-Up-To-Date Facts and Figures on Coal . . .

KEYSTONE COAL BUYERS MANUAL

Coal Mining . . . Coal Selling . . . Coal Transportation . . . and Coal Consumption Ever Published.

Coal Operating Companies Coal Mines and Cleaning Plants

1214 Companies, 1544 Mines, 615 Cleaning Plants that produce 90% of the national total. All the coal that moves in competitive markets, or is "Captive." Details show executives, managers, sales agents, location, transportation, mining and haulage equipment, capacity, employees and 1959 or 1958 actual production.

Coal Sales Organizations

565 Companies, showing main and district offices, executives, sales managers and listing coals handled.

Description of Seams

Descriptions of each coal field of each coal producing state and characteristics of each commercially mined seam.

River Transportation

Listing all river docks for loading, unloading and transferring.

Listing barge lines that handle coal.

Statistics on river coal traffic.

Overseas Export

Listing all major piers handling coal for overseas destinations.

Coke Plants

By states, showing company, executives responsible for fuel, locations, number and type of ovens, grades sold, coke and coal capacities, % L.V. coal used.

Electric Utility Generating Plants

By states, showing company, executives responsible for fuel, locations, fuel, 1959 fuel consumption, generating capacity and expansion 1960, 1961, 1962.

Projections of fuel use, 1960, 1961, 1962, 1963 and 1965.

Portland Cement Plants

By states, showing company, executives responsible for fuel, locations, capacity, fuel, 1959 fuel consumption, planned expansion.

All data secured from original sources. Not available elsewhere.

KEYSTONE COAL BUYERS MANUAL

A McGraw-Hill Publication

330 West 42nd Street New York 36, N. Y.

Buying Directory

Equipment . . . Materials . . . Services

EQUIPMENT, MATERIALS AND SERVICES FOR COAL MINING, together with the names of those who furnish them, are shown in Part 1 of this Buying Directory, starting on this page.

All products, materials and services, with their suppliers in each instance, are listed alphabetically under the key words. For example, look for "Bearings, Roller," rather than "Roller Bearings." If a product does not appear under one possible classification –for example, "Cable, Welding"–look for the alternative listing–in this instance, "Welding Cable."

BLACK-FACED TYPE indicates a manufacturer or supplier providing more detailed data on available equipment, materials and services through product-information advertisements in this issue (see p 436 for Advertising Index).

THE ADDRESSES of the manufacturers, suppliers and service organizations appearing in the Buying Directory are listed under the company names in the Directory of Manufacturers beginning on p 414 of this issue. For added convenience in obtaining equipment, services and materials offered by advertisers in this issue, their sales offices and representatives are shown in the Advertising Index beginning on p 420. A special Searchlight advertising section is indexed beginning on p 430.

ABRASIVES, DIAMOND INDUSTRIAL
Metallurgical Products Dept., General Electric Co.

ACETYLENE GENERATORS
Air Reduction Sales Co., Div. of Air Reduction Co., Inc.
Marathon Coal Bit Co., Inc.—"AIRCO"
Rexarc, Inc.—"SIGHT FEED"

ACTUATORS, CYLINDER, LINE VALVES
Ledeen, Inc.

ADDITIVES, FUEL OIL
Warren Refining & Chemical Co.—"PVR"

ADDITIVES, LUBRICANT
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Shell Oil Co.
Stewart-Warner Corp., Alemite Div.
Warren Refining & Chemical Co.—"PVR"

ADHESIVES
Automatic Vulcanizers Corp. (self-vulcanizing solutions)
B. F. Goodrich Industrial Products Co.—"PLASTILOCK," "VULCALOCK," "DUOLOCK"

AERATORS, BIN
The Bin-Dicator Co.—"BIN-FLO"

AERIAL PLATFORMS
Pitman Manufacturing Co.—"PITMAN"

AERIAL SURVEYING, MAPPING
Aerial Surveys, Inc.
American Air Surveys, Inc.
Jack Ammann, Inc. Engineers & Surveyors
Fairchild Aerial Surveys, Inc.

AERIAL TRAMWAYS
Interstate Equipment Corp.
Kurt Orban Co., Inc., Industrial Equipment Div.

AFTERCOOLERS, AIR
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Worthington Corp.

AFTERCOOLERS, COMPRESSOR
American-Standard Industrial Div.

AGITATOR CONDITIONERS
The Daniels Co.
Eimco Corp.
WEMCO Div., Western Machinery Co.—"WEMCO"

AGGREGATE PLANT
McDowell Co. Inc.—"DWIGHT-LLOYD®"

AIR CLEANERS, COAL
Link Belt Co., Dept. CAMGL—60
Roberts & Shaefer Company, Division of Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"

AIR COMPRESSORS
Allis-Chalmer Mfg. Co.
Chicago Pneumatic Tool Co.
M. Glosser & Sons Inc.
Lincoln Engineering Co., Div. of McNeil Machy. & Engrg. Co.
Schroeder Brothers Corp.
Stewart-Warner Corp., Alemite Div.

AIR COMPRESSORS, CENTRIFUGAL
Allis-Chalmer Mfg. Co.
American Standard Industrial Div.

AIR COMPRESSORS, DRILL-RIG
Davey Compressor Co.

AIR COMPRESSORS, PORTABLE, MINE
Acme Machinery Co.
Emglo Products Corp.—"EMGLO"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.—"MINEAIR"
Long-Airdox Co.—"AIRDOX"
Morse Bros. Machinery Co.

AIR COMPRESSORS, PORTABLE, SURFACE
Chicago Pneumatic Tool Co.
Davey Compressor Co.—"SUPER CHIEF," "AIR CHIEF," "PERMA-VANE"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.—"GYRO FLO"
Joy Mfg. Co.—"AIRVANE"
Le Roi Div., Westinghouse Air Brake Co.
Long-Airdox Co.—"AIRDOX"
Morse Bros. Machinery Co.
Schramm, Inc.—"PNEUMA-POWER," "UNISTAGE," "PNEUMADIESEL"
Worthington Corp.

AIR COMPRESSORS, SELF-PROPELLED
Acme Machinery Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Schramm, Inc.—"PNEUMA-TRACTOR"

AIR COMPRESSORS, STATIONARY
Allis-Chalmers Mfg. Co.—"ROFLO"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Emglo Products Corp.—"EMGLO"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co.—"INDUSTRIAL AIR"
Le Roi Div., Westinghouse Air Brake Co.
Long-Airdox Co.—"AIRDOX"
Morse Bros. Machinery Co.
Nash Engineering Co.
Ore Reclamation Co.
Pennsylvania Pump & Compressor Co.
Schramm, Inc.—"UNISTAGE"
Worthington Corp.

AIR CONDITIONERS
American-Standard Industrial Div.

AIR-LINE FILTERS
Aro Equipment Corp.
Hunt Valve Co.

AIR-LINE OILERS
Acme Machinery Co.
Aro Equipment Corp.
The Branford Co.—"BRANFORD"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.—"OIL-IR"
Joy Mfg. Co.
Schroeder Bros. Corp.
Stewart-Warner Corp., Alemite Div.
Thor Power Tool Co.

AIR RECEIVERS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Koven Fabricators, Inc.
Pennsylvania Pump & Compressor Co.
Worthington Corp.

AIR SEPARATORS, MECHANICAL
Hardinge Co., Inc.

Majac, Inc., Sub. of Blackstone Corp.
New Jersey Meter Co., Inc.—"DRI-AIR"
Universal Road Machinery Co.—"RELIANCE-GAYCO"
Western Precipitation Div., Joy Mfg. Co. "MULTICLONE"
Williams Patent Crusher & Pulv. Co.

AIR SUSPENSIONS
Clark Equipment Co.

ALARMS, BEARING-TEMPERATURE
The Bristol Co.—"BRISTOL'S"
Foxboro Co.
West Instrument Corp.

ALARMS, TRACTOR & TRUCK
E. D. Bullard Co.

ALARMS, TRUCK BACKUP
E. D. Bullard Co.

ALIDADES, PLANETABLE
Kern Instruments, Inc.

ALLOYS, ACID, CORROSION, WEAR-RESISTING
A. M. Byers Co.

ALLOYS, NICKEL
International Nickel Co., Inc.

ALTIMETERS
American Paulin System—"MICRO," "TERRA"

ALUMINUM
Joseph T. Ryerson & Son, Inc.

AMMETERS, CLAMP-ON
General Electric Co., Apparatus Sales Div.
Martindale Electric Co.

AMMETERS, INDICATING
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMETERS, RECORDING
The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMONIUM NITRATE, CARBO-NITRATE
Airmite-Midwest, Inc.

AMMONIUM NITRATE INDUSTRIAL
Allied Chemical Corp., Nitrogen Div.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Hercules Powder Co.
Industrial Chemicals Div., Spencer Chemical Co.
National Powder Co.

ANALYZERS, COAL-SULPHUR
Fisher Scientific Co.

ANALYZERS, GAS
Hays Corp.

ANALYZERS, SULPHUR, RAPID
Laboratory Equipment Co.—"LECO"

ANALYZERS,VOLATILIZATION
Laboratory Equipment Co.—"LECO"

ANEMOMETERS
Fisher Scientific Co.
Mine Safety Appliances Co.
National Mine Service Co.

ANTIFOAM AGENTS
Hodag Chemical Corp.

ANTI-FOG GOGGLE CLEANER
American Optical Co., Safety Products Div.—"SUPER-CLEAR"
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.—"FOGPRUF"
United States Safety Service Co.

ANTIFREEZE
American Minechem Co.
American Oil Co.
E. I. du Pont de Nemours & Co., Inc.—"TELAR," "ZERONE®" "ZEREX®"

ARCHES SUSPENDED FURNACE
Bigelow-Liptak Corp.

ARMATURE GROWLERS, TESTERS
Martindale Electric Co.
Snap-on Tools Corp.

ARMATURE REWINDING
Flood City Brass & Electric Co.
Guyan Machy. Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

ARMATURE TOOLS
Martindale Electric Co.

ASHING EQUIPMENT, RAPID
Laboratory Equipment Co.—"LECO"

ATHLETE'S-FOOT PREVENTIVE
Onox, Inc.—"ONOX"

AUDIO SYSTEMS
National Mine Service Co.—"FEMCO"

AUGER EXTENSIONS
The Leetonia Tool Co.
Long-Airdox Co.
Mobile Drilling, Inc.

AUGER FLIGHTS, CUTTER HEADS
Acker Drill Co., Inc.

AUGER SOCKETS
The Leetonia Tool Co.
Long-Airdox Co.
Mobile Drilling, Inc.

AUGERS, BREAST
Marathon Coal Bit Co., Inc.—"SALEM"
The Salem Tool Co.—"SALEM"

AUGERS, COAL-RECOVERY
Compton, Inc.
Link-Belt Co., Dept. CAMGL—60
Long-Airdox Co.
Marathon Coal Bit Co., Inc.—"SALEM"
The Salem Tool Co.—"McCARTHY"
Taylor-Wharton Co., Div. Harsco Corp.

AUGERS, COAL-SHOTHOLE
Central Mine Equipment Co.—"COALMASTER"
Dooley Bros.
Kennametal Inc., Mining Tool Div.
Long-Airdox Co.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN"
McLaughlin Mfg. Co., Inc.
Metallurgical Products Dept. General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
The Salem Tool Co.—"HERCULES"
Schroeder Bros. Corp.

AUGERS, EARTH
Acker Drill Co., Inc.—"ALL-PURPOSE (AP) DIGGER"
Central Mine Equipment Co.—"CME"
H & L Tooth Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
The Leetonia Tool Co.
Link-Belt Co., Dept. CAMGL—60
Long-Airdox Co.
Marathon Coal Bit Co., Inc. "McLAUGHLIN"
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
Pennsylvania Drilling Co.
The Salem Tool Co.—"BLACK DIAMOND"
The Wood Shovel & Tool Co.

AUGERS, ROCK-BLASTHOLE
Central Mine Equipment Co.—"CME"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Long-Airdox Co.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN"
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
The Salem Tool Co.—"McCARTHY"

AUGERS, ROOF-BOLTING
McLaughlin Mfg. Co., Inc.

AUGERS, ROOF DRILL
Kennametal Inc., Mining Tool Div.
Long-Airdox Co.

AUGERS, UNDERGROUND
The Salem Tool Co.

AUTOMATIC SPRINKLERS
The Fyr-Fyter Co.

AXES, MINERS'
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.—"AMERICAN" "RIXFORD," "AMERICAN CLIPPER," "ETHAN ALLEN"

AXLES, CARS, MINE EQUIPMENT
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co.—"GEMCO TRU-BLU"
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

AXLES, DRIVE, STEERING, AUTOMOTIVE SPECIAL
Clark Equip. Co., Automotive Div.

AXLES, FRONT, DRIVING
Rockwell Standard Corp., Transmission and Axle Div.

AXLES, FRONT, NON-DRIVING
Rockwell Standard Corp., Transmission and Axle Div.

AXLES, PLANETARY, STEERING AND RIGID
Rockwell Standard Corp., Transmission and Axle Div.

AXLES, REAR, SINGLE, TANDEM
Rockwell Standard Corp., Transmission and Axle Div.

AXLES, TRAILERS, TUBULAR AND I SECTION
Rockwell Standard Corp., Transmission and Axle Div.

BACK RIPPERS, BULLDOZER
Preco Incorporated—"PRECO"

BACKSTOPS
American Pulley Co.
Barber-Greene Co.
Chain Belt Co.—"REX"
Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated—"JONES"
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-60
Marland One-way Clutch Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Webster Mfg., Inc.

BAGS, AIR-FILTER
Bemis Bro. Bag Co.
C. R. Daniels Co.
The Daniels Co.
The Ducon Co., Inc.
John Flocker & Co.
Koppers Co., Inc., Metal Products Div.
National Filter Media Corp.
Western Precipitation Div., Joy Mfg. Co., "DUALAIRE," "THERM-O-FLEX"
Wheelabrator Corp.

BAGS, FOR AMMONIUM NITRATE
Bemis Bro. Bag Co.

BAGS, COAL WASHING FILTER
Filtration Engineers Div.—American Machine & Metals, Inc.
National Filter Media Corp.

BAGS, DISK-FILTER
The Eimco Corp.

BAGS, DISK-FILTER STAINLESS WIRE
Peterson Filters & Engineering Co.

BAGS, DUST COLLECTOR
National Filter Media Corp.

BAGS, EXPLOSIVES
Bemis Bro. Bag Co.

BAGS, MULTIWALL
Bemis Bro. Bag Co.—"RIPP-NIPP," "STRENGTH-END"
Chase Bag Co.

BAGS, POLYETHYLENE
Bemis Bro. Bag Co.—"FLIP-CLOSE" "FINE-WELD," "FLAP-LOK"
Chase Bag Co.
The Eimco Corp.
Peterson Filters & Engineering Co.—"SARAN"
Tamping Bag Co. Div., Pickard Industries, Inc.

BAGS, POWDER
American Brattice Cloth Co.
Bemis Bro. Bag Co.
C. R. Daniels Co.
Mine Safety Appliances Co.
National Powder Co.
Tamping Bag Co. Div., Pickard Industries, Inc.

BAGS, TAMPING
American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.
Bemis Bro. Bag Co.
Chase Bag Co.
E. I. du Pont de Nemours & Co., Inc.
National Mine Service Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Tamping Bag Co., Div., Pickard Industries, Inc.

BAGS, WATERPROOF
Bemis Bro. Bag Co.
Chase Bag Co.

BALLS, STEEL
New Departure Div., General Motors Corp.
SKF Industries, Inc.

BARGE-HANDLING EQUIPMENT
Connellsville Mfg. & Mine Supply Co.
Dravo Corp.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Company, Division of Thompson Starrett Company, Inc.
Sanford Day Iron Works, Inc.
Stephens-Adamson Mfg. Co.

BARGES
Bethlehem Steel Co.
Dravo Corp.
Marietta Manufacturing Co.
Wiley Manufacturing Co.

BAROGRAPHS
American Paulin System—"MICRO" "TERRA"

BAROMETERS
American Paulin System—"MICRO," "TERRA"
The Bristol Co.—"BRISTOLS"
Fisher Scientific Co.

BARRICADING KIT
Mine Ventilation Systems, Inc.

BARS, APPLICATOR
Stulz-Sickles Co.—"MANGANAL"

BARS, COLD-FINISHED
H. K. Porter Co., Connors Steel Div.—"CONNORS"

BARS, GRIZZLY
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Hewitt-Robins Incorporated
Kensington Steel, Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

BARS, MERCHANT

Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"CONNORS"

BARS, SLATE

Duquesne Mine Supply Co.
The Leetonia Tool Co.
The Salem Tool Co.—"SALEM"

BARS, STEEL (CARBON, STAINLESS, ALLOY)

A. M. Byers Co.

BARS, TAMPING

Bethlehem Steel Co.
Gibraltar Equipment & Mfg. Co.

BASKETS, CLOTHES

C. R. Daniels Co.
The Moore Co.—"LOCKER-BASKETS"

BATTERIES, DRY

United States Rubber Co.

BATTERIES, SHOT-FIRING

National Mine Service Co.

BATTERIES, STORAGE

C & D Batteries, Div. The Electric Autolite Co.—"SLYVER-CLAD®," "PLASTICELL," "PLASTICAL®"
Compton, Inc.
Thomas A. Edison Industries, McGraw-Edison Co., Storage Battery Div.—"EDISON"
Exide Industrial Div., The Electric Storage Battery Co.—"EXIDE-IRONCLAD," "EXIDE POWERCLAD"
Goodyear Tire & Rubber Co.
Gould-National Batteries, Inc.
Kersey Mfg. Co., Inc.
National Mine Service Co.
Yardney Electric Corp.—"YARDNEY SILVERCEL," "YARDNEY SILCAD"

BATTERY-CHARGING EQUIPMENT

Acme Electric Corp.—"MAGNI-STROL"
C & D Batteries, Div. The Electric Autolite Co.—"AUTO-REG®"
Exide Industrial Div., The Electric Storage Battery Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.—"GS"
Gould-National Batteries, Inc.
Hobart Bros. Co.
The Ironton Engine Co.—"IRON-TON"
Joy Mfg. Co.
Kersey Mfg. Co., Inc.
The Lincoln Electric Co.—"PRECISION-CHARGE"
Mine-Safety Appliances Co.
Syntron Co.

BEARING MATERIAL, PHENOLIC RESIN

American Brake Shoe Co., American Brakeblok Div.

BEARING METAL

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO"
Bearings, Inc.
Crucible Steel Co. of America
Imperial-Cantrell Mfg Co.—"IC"
Joseph T. Ryerson & Son, Inc.
Webster Mfg., Inc.
West Virginia Armature Co.

BEARING OILERS

Herold Mfg. Co.

BEARINGS, BALL

Ahlberg Bearing Co.—"AHL-BERG"
Bantam Bearings Div., Torrington Co.
Bearings Service Co.
Bearings, Inc.
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SC," "SLP," "SCM"
Ensign Electric & Mfg. Co.
The Fafnir Bearing Co.—"FAF-NIR"
The Federal Bearings Co., Inc.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BCA"
Flood City Brass & Electric Co.
Guyan Machy Co.
Link-Belt Co.—Dept. CAMGL-60 —"JPS"
Marlin-Rockwell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
National Mine Service Co.
New Departure Div., General Motors Corp.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Ore Reclamation Co.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Torrington Co.
Transall, Inc.
T. B. Woods Sons Co.—"LIFE LUBE"
West Virginia Armature Co.

BEARINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
Link-Belt Co., Dept. CAMGL-60

BEARINGS, CARBON

Helwig Carbon Products, Inc.
Ohio Carbon Co.—"KARAK"
Pure Carbon Co., Inc.

BEARINGS, HANGER

Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-60
Tulsa Winch, Div. of Vickers, Inc.—"TULSA (Two speed)"

BEARINGS, JOURNAL

American Brake Shoe Co., National Bearing Div.
American Brake Shoe Co., Railroad Products Div.
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Bearing Service Co.
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Chain Belt Co., Shafer Bearing Div.—"SHAFER SELF-ALIGNING"
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Hyatt Bearings Div., General Motors Corp.
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Bearings, Inc.
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Marlin-Rockwell Corp.—"M-R-C"
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Rollway Bearing Co., Inc.
SKF Industries, Inc.
Torrington Co.

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Transall, Inc.

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The Nolan Co.

BELTS, CHAIN

Link-Belt Co., Dept. CAMGL-60

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Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
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Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.—"HIGH FLEX"
Goodyear Tire & Rubber Co.
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Manheim Mfg. & Belting Co.
Ore Reclamation Co.
Paltech Co.
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Thermoid Co.
Thermoid Div., H. K. Porter Co. Inc.
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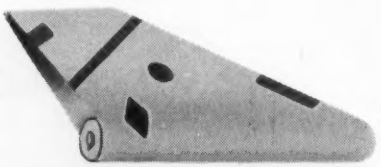
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Reliance Electric and Engrg. Co.

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Wagner Electric Corp.

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Rockwell-Standard Corp., Brake Div.

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Goodrich Co., B. F., Industrial Products Div.—"KOROSEAL"
National Mine Service Co.

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Pennsylvania Crusher Div., Bath Iron Works Corp.

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Marathon Coal Bit Co. Inc.—"IRON CITY"
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BRUSH-BLOCK ASSEMBLIES

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Stulz-Sickles Co.—"WING-DING" "SS CRESCENT"

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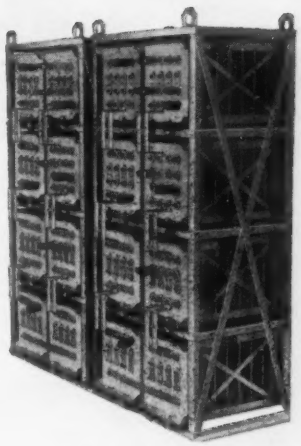
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Phelps Dodge Copper Products Co.
Rome Cable, Div. of Alcoa
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Circle Wire & Cable Corp.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.
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Okonite Co.
Phelps Dodge Copper Products Co.
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John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Simplex Wire & Cable Co.

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Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
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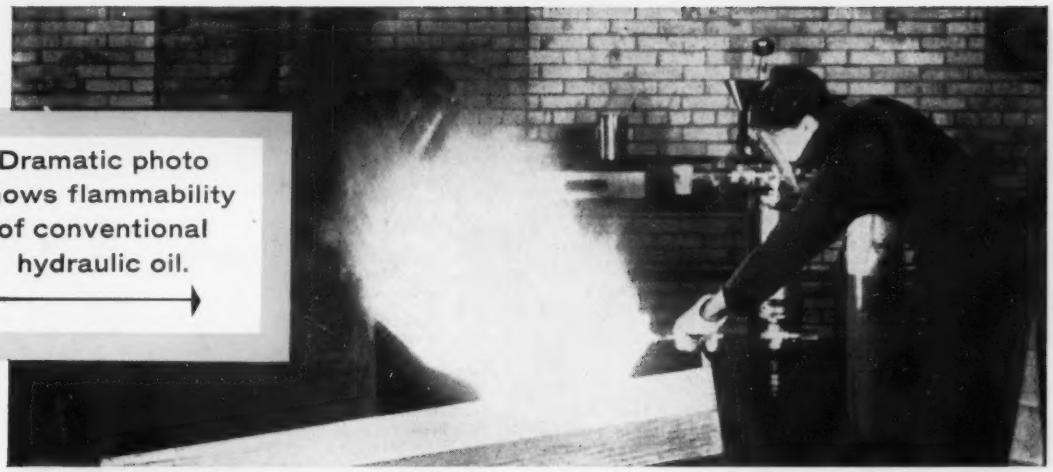
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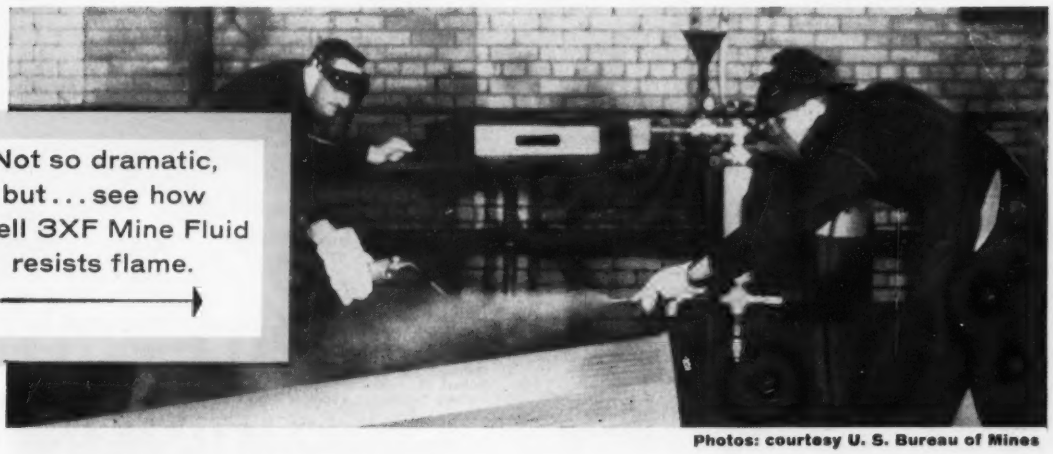
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Flood City Brass & Electric Co.
General Cable Corp.—"SUPER-SERVICE"
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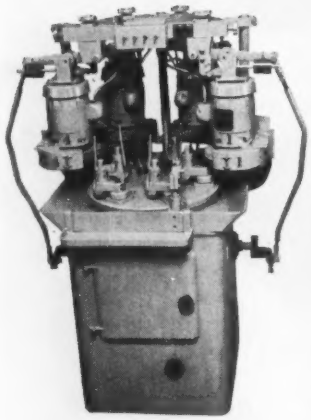
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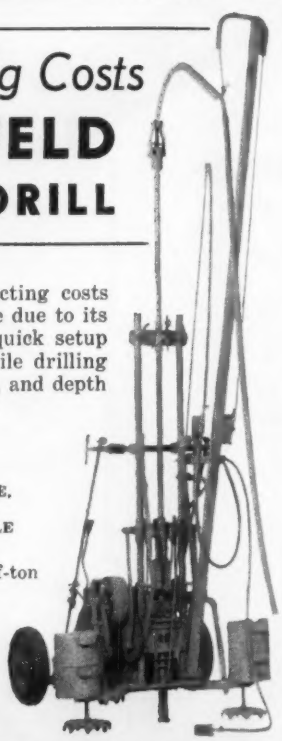
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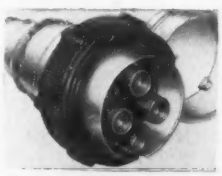
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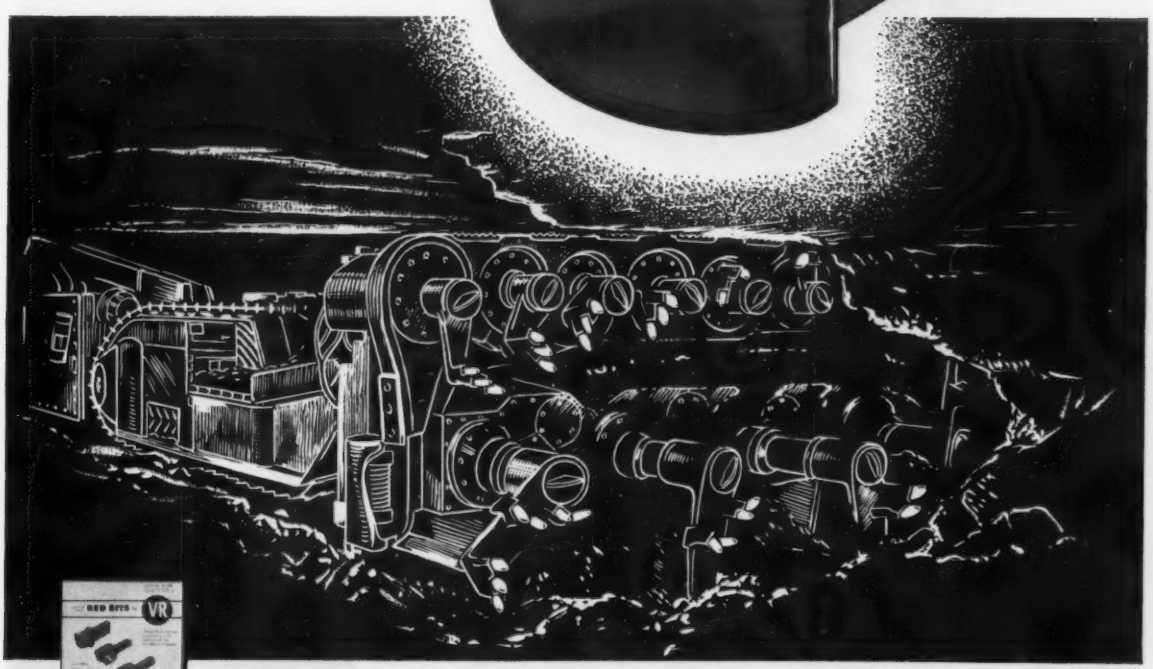
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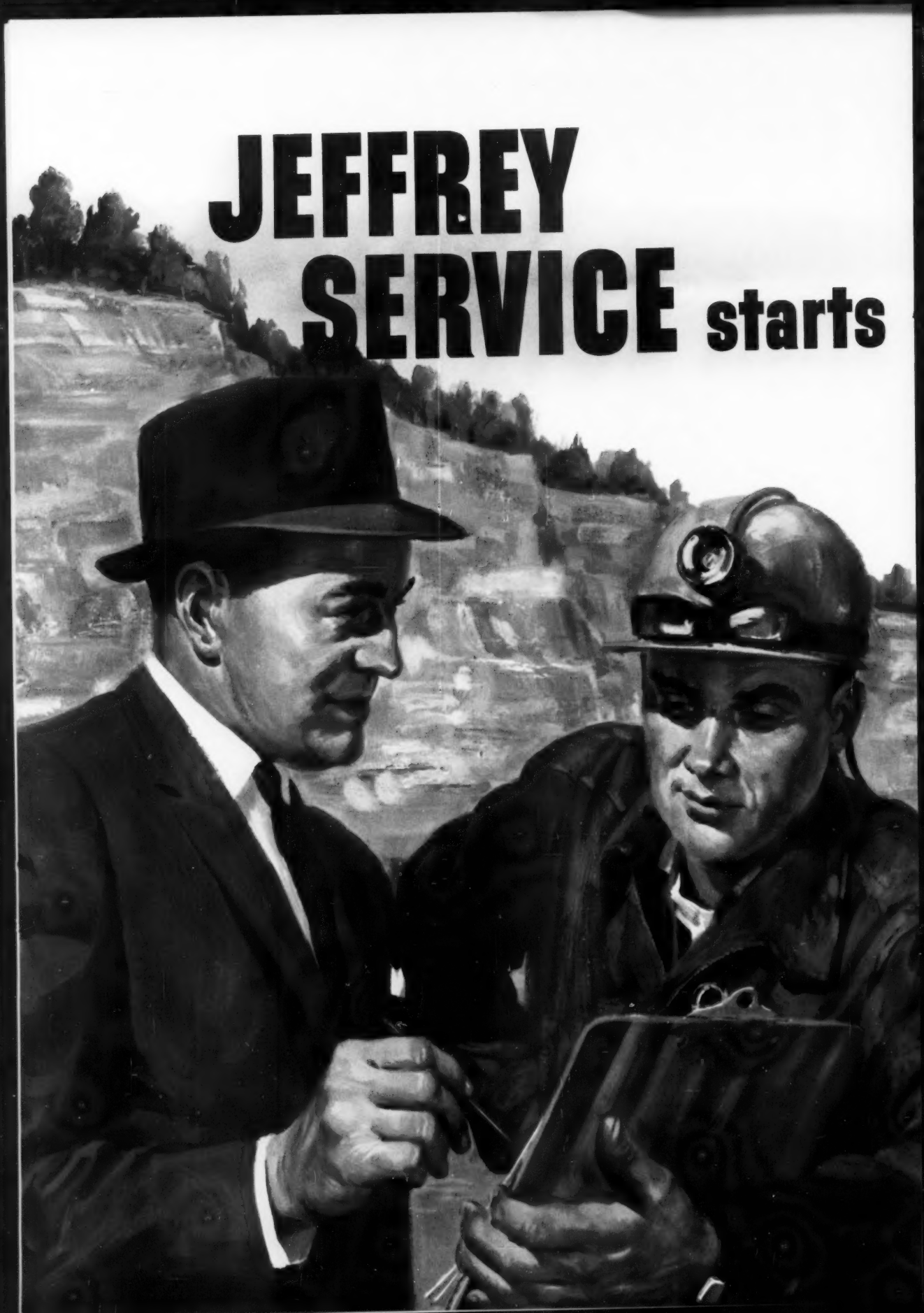
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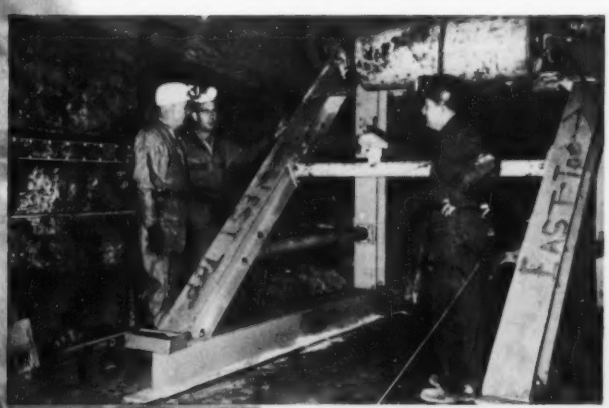
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JEFFREY TEAM ON THE JOB—System engineering gets follow through from an experienced team, as new equipment goes into service at Thunderbird Mine, Farmersburg, Indiana. Shown are L. E. Briscoe, Electrical Engineer for all Ayrshire properties, with Carl McCollum and William G. Urton, Jeffrey servicemen. Headframe for a 42″ Jeffrey rope-type belt conveyor is being installed for the main haulway.

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Barber-Greene Co.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WISSCO"
Continental Conveyor & Equipment Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CARICOAL"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE"
Industrial Rubber Products Co. (W. Va.)
Iowa Mfg. Co.
Joy Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-60—"LION," "SERVICE," "FAULTLESS"
Megator Corp.—"MEGATOR-GREENGATE"
National Mine Service Co.—"SCANDURA"
New York Rubber Co.
Paltech Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"RECORD-MAKER"
W. J. Savage Co.
Scandura, Inc.—"SCANDURA," "GOLD LINE"
Smith Engineering Works
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
Transall, Inc.
United States Rubber Co.
"RUSLON P.V.C."

CONVEYOR BELTING, RAYON FOR

American Enka Corp.

CONVEYOR-BELTING CLEANERS

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Continental Conveyor & Equipment Co.
Nelson L. Davis Co. —"NELDCO"
Hewitt-Robins Incorporated
Joy Mfg. Co.
Kanawaha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Stephens-Adamson Mfg. Co.
Transall, Inc.
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Crescent Belt Fastener Co. (Plates & Rivets)—"CRESCENT"

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A DW21 and No. 470 Scraper average 4½ minutes cycle time on 1,100 ft. haul.

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Stripping blocks of coal left next to abandoned underground mines is nearly always tough going, especially when it means moving material soaked with water from underground springs. Here's how the Gillen Coal Mining Company of Carbondale, Pa., solved the problem: with 180 ft. of overburden to remove, they assigned two Cat DW21 Tractors the job of removing 10 feet of topsoil and 100 feet of hardpan. The remaining 70 ft. of rock over the coal seam was removed by a 6-yd. shovel. With DW21s removing the upper portion, production increased and costs went down.

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Working under these rugged conditions, the two DW21s equipped with No. 470 Scrapers and pushloaded by a Cat D9 Tractor followed the bench method of stripping and moved up to 4,000 yards a seven-hour shift, each yard weighing 3,200 lb.

Now, with the DW21 Series G even higher production records are possible. 345 HP enables it to deliver more rimpull and permits 20 per cent faster travel speeds under similar haul road conditions. Both the tractor and the No. 470 LOWBOWL Scraper have design and structural improvements to meet your needs for moving more dirt at a lower cost than ever: the tractors have stronger final drive gears and improved transmission shifter forks; scrapers have stronger bowls, draft frames, and aprons.

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Talcott, Inc.
Transall, Inc.
United States Rubber Co.

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Automatic Vucanizers Corp.— "PANG"
Crescent Belt Fastener Co. (Plates & Rivets)—"CRESCENT"
General Splice Corp.—"MINET," "SELF VULCANIZING"
B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated
Linatex Corp. of America
Reid Belt & Rubber Co. Inc.
Rema-Tech, Inc.
United States Rubber Co.
West Virginia Belt Repairs, Inc.

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Automatic Vulcanizers Corp.
Crescent Belt Fastener Co. (Plates & Rivets)—"CRESCENT"
B. F. Goodrich Industrial Products Co.
General Splice Corp.—"MINET"
Goodyear Tire & Rubber Co.
Joy Mfg. Co.
Rema-Tech, Inc.

CONVEYOR BELTING TIGHTENERS

Hewitt-Robins Incorporated

CONVEYOR-BELTING VULCANIZERS

Automatic Vulcanizers Corp.
B. F. Goodrich Industrial Products Co.
Heintz Mfg. Co.
Rema-Tech, Inc.

CONVEYOR COVERS

Armco Drainage & Metal Prod., Inc.
Arrowhead Engineers and Constructors, Inc.
Barber-Greene Co.
Continental Conveyor & Equipment Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
E. F. Marsh Engrg. Co. — "MARCO"
Pioneer Engineering, Div. of Poor & Co.
McNally Pittsburg Mfg. Corp.
Thomas Engineering & Construction Co.
Transall, Inc.

CONVEYOR LOADERS, UNDERGROUND

The Eimco Corp.

CONVEYOR LOADING CHECKS

Daly Ticket & Printing Co. — "DALY'S"

CONVEYOR PULLEY LAGGING

General Splice Corp.—"MINET," "COLDBOND"
Hewitt-Robbins Incorporated
Link-Belt Co., Dept. CAMGL-60

CONVEYOR WEIGHERS

ABCs Scale Div., McDowell Co., Inc.—**"ABCs"®**
B-I-F Industries, Inc.—"CONVEYELO," "PNEU-WEIGH"
Industrial Physics & Electronics Co.—"CON-O-WEIGH"
Merrick Scale Mfg. Co.— "WEIGHTOMETER"
Thurman Scale Co., Div. Thurman Mfg. Co.

CONVEYORS, APRON

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Continental Conveyor & Equipment Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.— "MARCO"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co. — "AMSCO"
Webster Mfg. Inc.

CONVEYORS, APRON, CURVE-GOING

Herold Mfg. Co.
Link-Belt Co., Dept. CAMGL-60

CONVEYOR, APRON, REPAIRS

Leman Machine Co.
Link-Belt Co., Dept. CAMGL-60

CONVEYORS, BELT

American Conveyor Co.— "CON-VAY-IT," "STOKER-VEYOR"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. "LIMA AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mfg. Co., Inc— "HI-SPEED"
Carlyle Rubber Co., Inc.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div. —"WISSCO"
Compton, Inc.
Continental Conveyor & Equipment Co.
Diamond Iron Works Div. Goodman Mfg. Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Herold Mfg. Co.
Hewitt-Robins Incorporated— "AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE."
Heyl & Patterson, Inc.
The Homer Mfg. Div., The Ohio Electric Mfg. Co.— "HOMER"
Iowa Mfg. Co.
Irwin Sensenich Corp.
Jeffery Mfg. Co.
Joy Mfg. Co. (& conventional)— "LIMBEROPE," "READY-SPAN"
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-60 "LINK BELT," "PRE-BILT"
Lippmann Engrg. Works Inc.
Long-Airdox Co.
E. F. Marsh Engrg. Co.— "MARCO"
Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
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United States Rubber Co.
Universal Road Machinery Co.— "RELIANCE"
Webster Mfg. Inc.

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Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated— "MINE-AVEYORS"
Jeffery Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60 —"PRE-BILT"
Long-Airdox Co.—"FULL DIMENSION SYSTEM"
E. F. Marsh Engrg. Co.— "MARCO"
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

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American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
Baughman Mfg. Co., Inc.— "HI-SPEED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyors & Equipment Co.
Fairmont Machinery Co.
The Gallagher Co.
Hewitt-Robins Incorporated
Jeffery Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engrg. Works, Inc.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, BUCKET-WHEEL

Link-Belt Co., Dept. CAMGL-60

CONVEYORS, CABLE-BELT

National Mine Service Co.

CONVEYORS, CHAIN AND BUTTON

Mining Progress, Inc.

CONVEYORS, CHAIN, CHAIN & FLIGHT

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American Conveyor Co.— "FLIGHTVEYOR"
American Well Works
Chain Belt Co.—"REX"
J. D. Christian Engineers
Columbus McKinnon Chain Corp., Mining Equipment Div.— "POWER-FLEX"
Compton, Inc.
Continental Conveyor & Equipment Co.
The Daniels Co.
Electric Steel Foundry Co.
Electric Alloys Div., American Brake Shoe Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Helmick Foundry-Machine Co.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div of Poor & Co.
Link-Belt Co., Dept. CAMGL-60 FLITE-FLO
Long-Airdox Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Mining Progress, Inc.
National Mine Service Co., Clarkson Div.—"REDBIRD," "UNIFLIGHT"
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Thomas Engineering & Construction Co.
Transall, Inc.
Vulcan Iron Works, Inc.
Watt Car & Wheel Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, CHAIN, SINGLE OR DOUBLE CHAIN & FLIGHT

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Link-Belt Co. Dept. CAMGL-60— "LINK-BELT," "RIVETLESS," "LXS," "RC," "FR"
Mining Progress, Inc.

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Carrier Conveyor, div. Chain Belt Co.
Link-Belt Co., Dept. CAMGL-60

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Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Irwin Sensenich Corp.
Jeffery Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60— "BULK-FLO," "LINK-BELT," "PRE-BILT"
Lippmann Engrg. Works Inc.
Long-Airdox Co.
E. F. Marsh Engrg. Co.— "MARCO"
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Roberts & Schaefer Company Division of Thompson-Starrett Company Inc.
Stephens-Adamson Mfg. Co.— "REDLER," "ZIPPER"
Transall, Inc.
United States Rubber Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, ELEVATING, MINE TRANSFER, CAR LOADING

Hewitt-Robins Incorporated

CONVEYORS, EXTENSIBLE CHAIN

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Wilcox Mfg. Co.—"WILCOX"

CONVEYORS, MINE

Link-Belt Co., Dept. CAMGL-60

CONVEYORS, MINE BRIDGE

Goodman Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Long-Airdox Co.—"PIGGYBACK"
E. F. Marsh Engrg. Co.— "MARCO"

CONVEYORS, MOBILE HEAD, CHAIN

Long-Airdox Co.

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Link-Belt Co., Dept. CAMGL-60 —"LINK-BELT," "ELEMOUNT," "COILMOUNT," "TORQMOUNT"

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Convair
Kennedy Van Saun Mfg. & Eng. Corp.
Baldwin P1 Coal Age (GB July)

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Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mfg. Co. Inc.— "HI-SPEED"
J. D. Christian Engineers
Goodman Mfg. Co.
Herold Mfg. Co.
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Joy Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.— "MARCO"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pettibone Mulliken Corp., Haiss Div.
Pioneer Engineering, Div. of Poor & Co.
Stephens-Adamson Mfg. Co.

CONVEYORS, ROPE

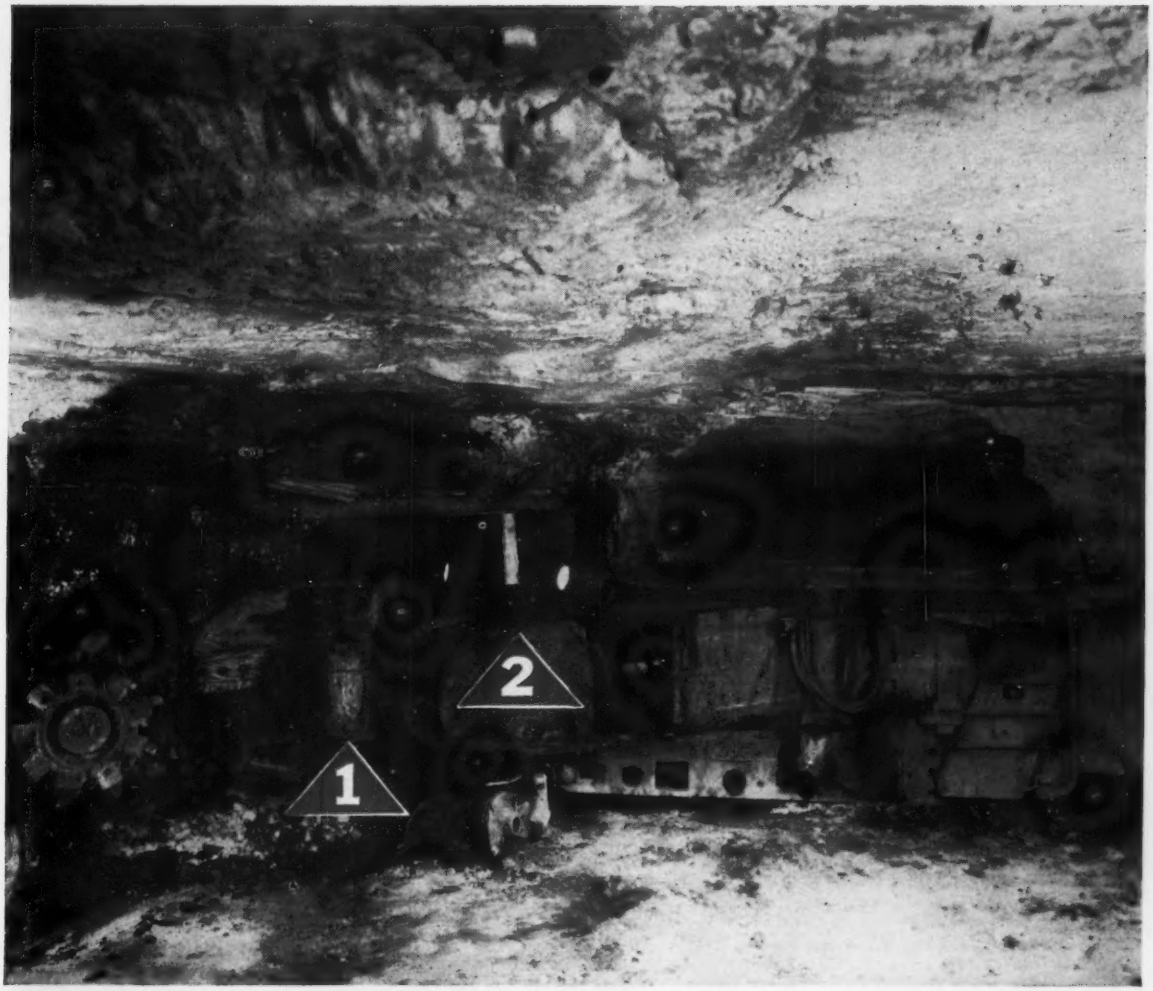
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CONVEYORS, ROPE & BUTTON

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Jeffrey Mfg. Co.
Kanawha Mfg. Co.
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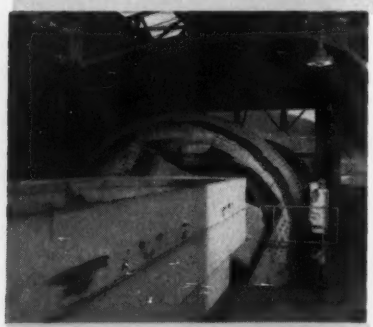
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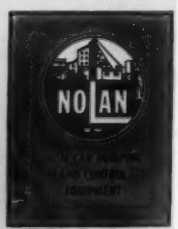
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General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
H. K. Porter Co., Inc., National Electric Div.—"INDESTRUCTO"
Rome Cable, Div of Alcoa—"ROME 60," "ROME 50"
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National Malleable & Steel Castings Co.—"WILLISON," "SHARON 10"
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Rydin Railway Equip. Co.

COUPLERS, MINE-CAR

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Lincoln Engrg. Co., div. of McNeil Mach. & Engrg. Co.—"FLEX-O-MATIC"
Marman Div. Aeroquip Corp.—"CONOSEAL"
McDowell Mfg. Co.—"FAST-LINE"
Schroeder Brothers Corp.

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Acme Chain Corp.
Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-60—"RC"

COUPLINGS, CLUTCH

Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-60
Marland One-Way Clutch Co.

COUPLINGS, CONTINUOUS SLEEVE

Link-Belt Co., Dept. CAMGL-60
Zurn Industries, Inc., Mechanical Power Transmission Div.

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The Fyr-Fyter Co.
Hewitt-Robins Incorporated

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Dodge Mfg. Corp.
Farrel-Birmingham Co., Inc.
Link-Belt Co., Dept. CAMGL-60
McDowell Mfg. Co.

COUPLINGS, FLEXIBLE SHAFT

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J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
Elliott Co.
The Falk Corp.—"STEELFLEX," "AIRFLEX"
Flood City Brass & Electric Co
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Koppers Co., Inc., Metal Products Div.—"FAST'S"
Link-Belt Co., Dept. CAMGL-60—"RC," "GEARED," "MC"
Morse Chain Co., A Borg-Warner Industry—"MOR-FLEX" (roller, silent, nylon)
Thomas Flexible Coupling Co.—"THOMAS"
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
T. B. Woods Sons Co.—"SURE FLEX"
Zurn Industries, Inc., Mechanical Power Transmission Div.—"AMERICAN-AMERIGEAR"

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Dolge Mfg. Corp.—"TAPER-LOCK"
Link-Belt Co., Dept. CAMGL-60

COUPLINGS, FLUID DRIVE

Dodge Mfg. Corp.—"TAPER-
Link-Belt Co., Dept. CAMGL-60
Twin Disc Clutch Co.

COUPLINGS, FLUID & HYDRAULIC LINES

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Blackhawk Industrial Div.
Champ Industries, Inc.
Chiksan Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories Co.
Link-Belt Co., Dept. CAMGL-60
McDowell Mfg. Co.—"FAST-LINE"
Weatherhead Co., Fort Wayne Div.

COUPLINGS, GROOVED-END PIPE

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COUPLINGS, HOSE

Acme Machinery Co.
Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hewitt-Robins Incorporated
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—"LOKTITE"
Meckum Engineering, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.
United States Rubber Co.—"EVERTITE"
Weatherhead Co., Fort Wayne Div.

COUPLINGS, HYDRAULIC

Link-Belt Co., Dept. CAMGL-60

COUPLINGS, HYDRAULIC-DRIVE

Link-Belt Co., Dept. CAMGL-60

COUPLINGS, MAGNETIC-DRIVE

Dynamatic Div., Eaton Mfg. Co.

COUPLINGS, PLAIN END PIPE

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Victualic Co. of America—"VICTUALIC ROUST-ABOUT" "VICTAULIC PLAINLOCK"

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Hewitt-Robins Incorporated
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COUPLINGS, SHAFT, FLEXIBLE, RIGID, COMPRESSION CHAIN

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COUPLINGS, SWIVEL, BRONZE

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COVERING, FLOOR, STAIR

Minnesota Mining & Mfg. Co. "SAFETY WALK"

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Link-Belt Speeder Corp.

CRANES, GANTRY

American Hoist & Derrick Co.

CRANES, GANTRY & WALL

Shepard Niles Crane & Hoist Corp.

CRANES, JIB & BRACKET

Shepard Niles Crane & Hoist Corp.

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Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
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Dravo Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Hyster Co.—"HYSTER KARRY KRANE"
Koehring Div. of Koehring Co.—"CRUISER-CRANE"
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

CRANES, RUBBER-TIRED, SELF-PROPELLED

Link-Belt Speeder Corp.

CRANES, SHOP & PLANT

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Columbus McKinnon Chain Corp. Mining Equipment Div.
Guyan Machy. Co.
Harnischfeger Corp.
Manning Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"SHAW BOX," "LOAD LIFTER"
Morse Bros. Machinery Co.
Robbins & Myers, Inc.—"R & M"
Shepard Niles Crane & Hoist Corp.

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Allis-Chalmers Mfg. Co.
Hyster Co.

CRANES, TRACTOR & TRUCK

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Baldwin-Lima-Hamilton Corp. Construction Equipment Div.—"LIMA"
FWD Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Insley Mfg. Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.

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Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
FWD Corp.
Gar Wood Industries, Inc.
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Insley Mfg. Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.—"SEPHYRCRANES"
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Pitman Manufacturing Co.—"PITMAN HYDRA LIFT"
"Quick-Way" Truck Shovel Co.
Ruger Equipment, Inc—"RUGER"
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN MOTOCRANE"

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Hendrickson Mfg. Co.

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McLanahan & Stone Corp.

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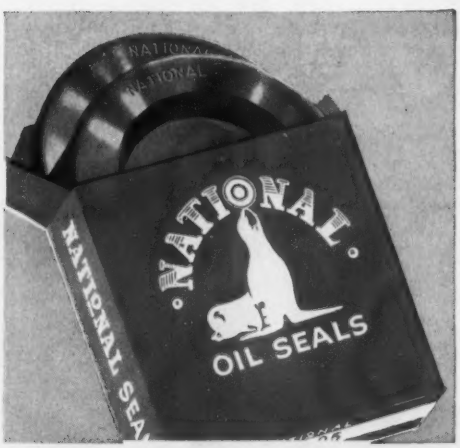
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Link-Belt Speeder Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
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Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
National Mine Service Co.
Paris Mfg. Co.
The Salem Tool Co.—"McCARTHY"
Schroeder Brothers Corp.
Taylor-Wharton Co. Div., Harsco Corp.
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Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
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The Salem Tool Co.—"McCARTHY"

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DRILL CORE BARRELS

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DRILL HEAD

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DRILL JUMBOS

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Gardner-Denver Company
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Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Machinery Center, Inc.
Mayo Tunnel & Mine Equipment
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Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.
Mobile Drilling, Inc.
National Supply Company—"SPANGWELD," "DOUBLE SEAL SHRINK THREAD"
National Tube Div. United States Steel Corp.—"USS NATIONAL"

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DRILL TOOLS, CHURN

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The Cincinnati Electric Tool Co.
Ensign Electric & Mfg. Co.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Penn Machine Co.
Schroeder Brothers Corp.

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Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Galis Electric & Machine Co.—"GALIS 400"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Lee-Norse Company—"LEE-NORSE DRILL TRUCK"
Mobile Drilling, Inc.
Paris Mfg. Co.
Penn Machine Co.
The Salem Tool Co.—"McCARTHY"
Winter-Weiss Co.—"PORTA-DRILL"

DRILLS, COAL, POST-MOUNTED

Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Jeffrey Mfg. Co.
The Leetonia Tool Co.
Morse Bros. Machinery Co.
Penn Machine Co.
The Salem Tool Co.—"SALEM"

DRILLS, COAL RECOVERY

Long-Airdox Co.
The Salem Tool Co.

DRILLS, COMBINATION ROTARY & DOWN THE HOLE

REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, CORE

Acker Drill Co.—"HILLBILLY," "TEREDO," "PACKSACK," "MODELS LD, KR," "PRESIDENTE"
Chicago Pneumatic Tool Co.—"CP"
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"HOLEMASTER"
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
Mobile Drilling, Inc.
Pennsylvania Drilling Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Sprague & Henwood Inc.
Winter Weiss Co.—"PORTA-DRILL"

DRILLS, CORE, PORTABLE

Acker Drill Co., Inc.—"ACKER PACKSACK (AIR)"

DRILLS, CRAWLER-MOUNTED

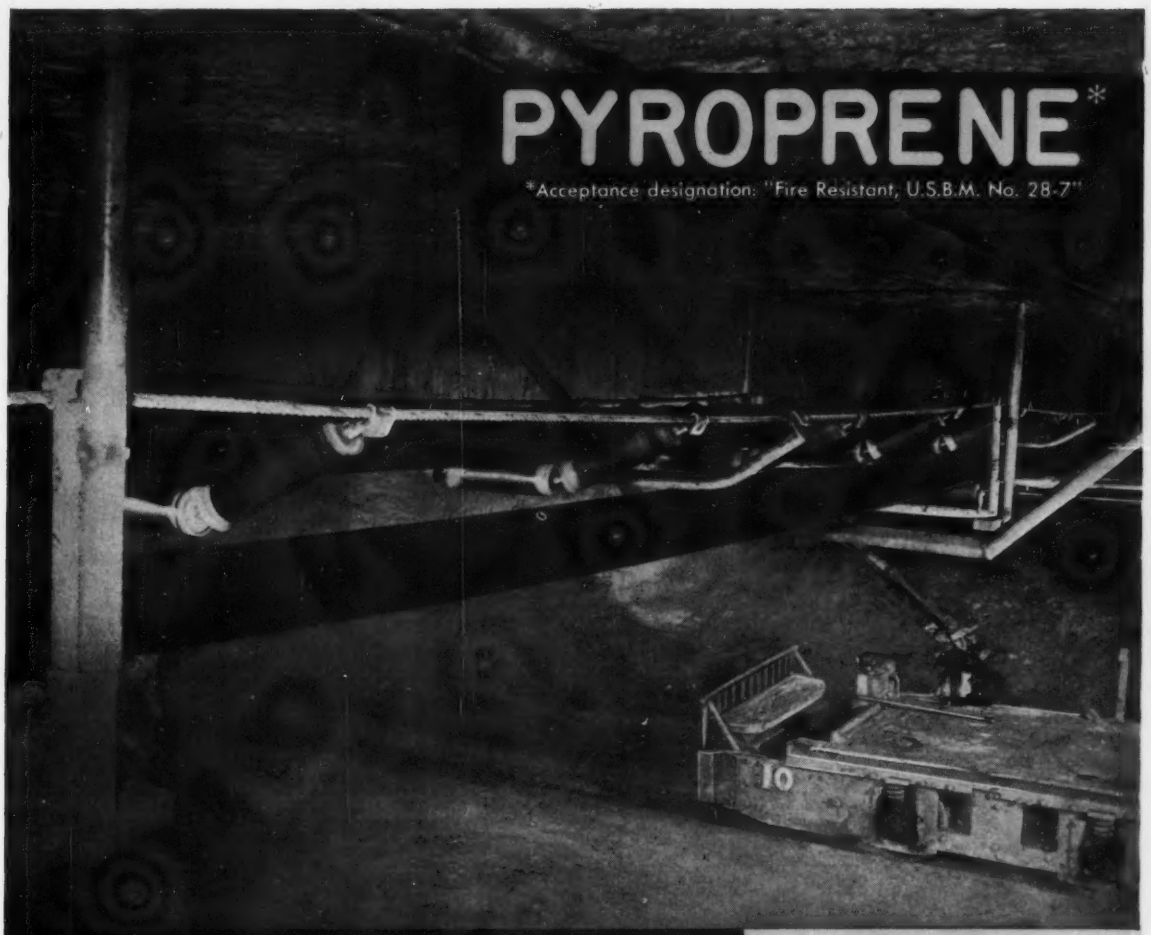
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Thor Power Tool Co.

DRILLS, HIGHWAY, HORIZONTAL, AUGER

Long-Airdox Co.
The Salem Tool Co.—"McCARTHY"

PYROPRENE*

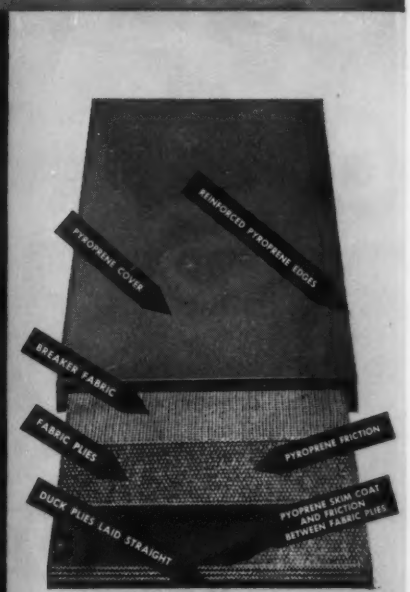
*Acceptance designation: "Fire Resistant, U.S.B.M. No. 28-7"



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This Acme-Hamilton 48-in. conveyor belt, on a Goodman Ropebelt Conveyor is carrying coal at 1500 tph with low maintenance costs and long service life. Note how nicely the belt troughs under the bulky load—and how flat it runs between the return idlers . . . sure signs of excellent construction and fine quality.

PYROPRENE PROTECTED against fire, Acme-Hamilton U.S.B.M. accepted belts will not feed or spread fire. The cover is fire-resistant Pyroprene; fabric plies and breaker fabric are encased with Pyroprene compound before the belt is built. Cover has exceptional resistance to abrasion and cutting. Write Acme-Hamilton Dept. CA-91.



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Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
Pennsylvania Drilling Co., Masonry Drill Div.

DRILLS, OVERBURDEN, CRAWLER & TRACTOR MOUNTED

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DRILLS, OVERBURDEN DOWN-THE HOLE

Long-Airdox Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Schramm, Inc.—"ROTATOOL"

DRILLS, OVERBURDEN, ROTARY-PERCUSSION

Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"BLASTMASTER"

DRILLS, OVERBURDEN, SIDEWALL

Chicago Pneumatic Tool Co.—"CP"
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"HD-1-HOLEMASTER"
Joy Mfg. Co.
Long-Airdox Co.
Mobile Drilling Inc.
Paris Mfg. Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
The Salem Tool Co.—"McCARTHY"

DRILLS, OVERBURDEN, TRACTOR-MOUNTED PNEUMATIC

Chicago Pneumatic Tool Co.—"TRACDRIL"
Gardner-Denver Company
Joy Mfg. Co.—"CHALLENGER"
Schramm Inc.—"PNEUMATRACTOR ROTADRILLS, Models P-41 & P-42"
Winter-Weiss Co.—"PORTADRILL"

DRILLS, OVERBURDEN, TRACTOR-MOUNTED, ROTARY

Davey Compressor Co.

DRILLS, OVERBURDEN, VERTICAL AUGER

Long-Airdox Co.
The Salem Tool Co.—"McCARTHY"

DRILLS, OVERBURDEN, VERTICAL CHURN

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Buffalo-Springfield Co., Div. of Koehring Co.—"SPEED TAR," "KEYSTONE"

DRILLS, OVERBURDEN, VERTICAL ROTARY

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Buffalo-Springfield Co., Div. of Koehring Co.—"KEYSTONE-FRANKS"
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"HOLEMASTER"
Ingersoll-Rand Co.
Joy Mfg. Co.—"CHAMPION"
Long-Airdox Co.
Mobile Drilling Inc.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Robbins Machine & Mfg. Co.
The Salem Tool Co.—"McCARTHY"
Schramm, Inc.—"ROTADRILL TRUCK MOUNTED, Models T-64 & T-66"; "ROTADRILL CRAWLER MOUNTED, Models C-42 & C-66"; "ROTADRILL TRAILER MOUNTED, Model R-66"
Winter-Weiss Co.—"PORTADRILL"

DRILLS, OVERBURDEN, VERTICAL ROTARY, TRUCK MOUNTED

Davey Compressor Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, PNEUMATIC

Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Gardner-Denver Company
Ingersoll-Rand Co.—"VACUJET," "JACKDRILL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Schramm, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILLS, PNEUMATIC, HAND-HELD

Davey Compressor Co.—"DAVEY-HOLMAN"

DRILLS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.

DRILLS, PROSPECTING

Chicago Pneumatic Tool Co.
Hossfeld Mfg. Co.—"HOSSFELD FELD DIRECT DRIVE"
Long-Airdox Co.
Mobile Drilling, Inc.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"

DRILLS, POWER-TAKE-OFF OPERATED

Long-Airdox Co.
Mobile Drilling Inc.

DRILLS, ROCK, ELECTRIC, PORTABLE

Homelite, a div. of Textron, Inc.—"HOMELITE-(BOSCH)"

DRILLS, ROOF-BOLTING

Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
The Eimco Corp.
J. H. Fletcher & Co.
Galis Electric & Machine Co.—"GALIS 300," "GALIS 320"
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILLS, ROTARY, PERCUSSIVE ROTARY PERCUSSION

Galis Electric & Machine Co.

DRILLS, ROOF-BOLTING, ROTARY IMPACT TOOLS

Impact Rotor Tool, Inc.

DRILLS, ROOF-BOLTING, ROTARY PERCUSSION

Galis Electric & Machine Co.

DRILLS, ROTARY, PERCUSSIVE

Chicago Pneumatic Tool Co.
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"FP-3 HOLEMASTER"

DRILLS, SHOT

Acker Drill Co. Inc.—"MODEL KR"

DRILLS, STRIP-COAL, TRACTOR-MOUNTED PNEUMATIC

Chicago Pneumatic Tool Co.—"H-BOOM"
Joy Mfg. Co.—"CHALLENGER"
Long-Airdox Co.
The Salem Tool Co.—"McCARTHY"
Schramm, Inc.—"PNEUMATRACTOR ROTADRILLS, Models P-41 & P-42"; "CRAWLER MOUNTED ROTADRILLS, Models C-42 & C-66"

DRILLS, STRIP-COAL, VERTICAL ELECTRIC

Long-Airdox Co.
The Salem Tool Co.—"McARTHY"

DRILLS, WAGON

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Electric Machinery Mfg. Co.—"AMPLI-SPEED"
General Electric Co., Apparatus Sales Div.
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Link-Belt Co., Dept. CAMGL-60—"P. I. V.," "R. S. P. I. V."
Reliance Electric & Eng. Co.—"RELIANCE V-S"
Worthington Corp.

DRIVES, BELT

Dodge Mfg. Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60
Morse Chain Co., A Borg-Warner Industry—"TIMING"

DRIVES, CHAIN

Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER-LOCK"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT," "LXS," "RIVETLESS" "RC"
Morse Chain Co., A Borg Warner Industry—"HY-VO"
National Supply Company—"NATIONAL"
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

DRIVES, CONVEYOR

Allis-Chalmers Mfg. Co.
Barber-Greene Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60

DRIVES, ELEVATOR

Link-Belt Co., Dept. CAMGL-60

DRIVES, FLANGE-MOUNTED

Dodge Mfg. Corp.
The Falk Corp.
Link-Belt Co., Dept. CAMGL-60

DRIVES, FLUID

American-Standard Industrial Div.
Dodge Mfg. Corp.—"FLEXI-DYNE"
Link-Belt Co., Dept. CAMGL-60—"ELECTROFLUID"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Twin Disc Clutch Co.

DRIVES, GEAR

The Louis Allis Co.
The Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Co.—"GEARMOTOR," "LINE-O-MOTOR," "LINE-O-MOUNT," "SHAFTMOUNT"
FWD Corp.
Hewitt-Robins Incorporated—"JONES"
Kanawha Mfg. Co.
Link-Belt Co., Dept., CAMGL-60—"LINK-BELT," "PARALLEL," "INLINE HELICAL," "WORM," "UNIVERSAL," "GEARMOTOR," "MOTO-GEAR"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Pittsburgh Gear Co.
Reliance Elec. & Eng. Co.
U. S. Electrical Motors, Inc.—"SYNCRO-GEAR"

DRIVES, HYDRAULIC

Link-Belt Co., Dept. CAMGL-60
Vickers Incorporated

DRIVES, ROLLER CHAIN

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Link-Belt Co., Dept. CAMGL-60 "FR," "RC," "SILVERBRITE"
Morse Chain Co., A Borg-Warner Industry

DRIVES, SELECTIVE-SPEED

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60—"P.I.V.," "R.S.V.I.P."

DRIVES, SHAFT—MOUNTED

Dodge Mfg. Corp.
The Falk Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT"

DRIVES, SILENT CHAIN

Link-Belt Co., Dept. CAMGL-60—"SILVERSTREAK"
Morse Chain Co., A Borg-Warner Industry

DRIVES, V-BELT

The American Pulley Co.
J. D. Christian Engineers
Dayton Industrial Products Co.—"DAYTON"
Dodge Mfg. Corp.—"DYNA-V" "TAPER LOCK"
Flood City Brass & Electric Co.
The Gates Rubber Co.
Guyan Machy Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (W. Va.)
Iowa Mfg. Co.
Kanawha Mfg. Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"POLY-V"
Stephens-Adamson Mfg. Co.
Thermoid Co.
Worthington Corp.

DRIVES, VARIABLE-SPEED

The American Pulley Co.
J. D. Christian Engineers
Clark Controller Co.
Cleveland Worm & Gear Div., Eaton Mfg. Co.—"VARIATOR" (Mechanical)
Dodge Mfg. Corp.
Dynamatic Div., Eaton Mfg. Co. "AJUSTO-SPEDE," "DYNASPEDE"
Foote Brothers Gear & Machinery Corp.—"VARI-MOUNT"
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60—"P.I.V." "R.S.P.I.V."
Manheim Mfg. & Belting Co.—"MVS"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Reeves Pulley Co. Div., The Reliance Electric & Engineering Co.—"VARI-SPEED"
Reliance Electric & Eng. Co.—"RELIANCE V—S"
Sterling Electric Motors, Inc.—"STERLING SPEED-TROL"
U.S. Electrical Motors, Inc.—"VARI-DRIVE"
Vickers Incorporated
Worthington Corp.

DRIVES, VARIABLE-SPEED EDDY-CURRENT

Dynamatic Div., Eaton Mfg. Co.—"AJUSTO-SPEDE," "DYNASPEDE"
Hewitt-Robins Incorporated
Kanawha Mfg. Co.

DRIVES, VARIABLE-SPEED, HYDRAULIC

American Engineering Co.—"HELE-SHAW"
Link Belt Co., Dept. CAMGL-60

DRIVES, WORM-GEAR

Cleveland Worm & Gear Div., Eaton Mfg. Co.—"CLEVELAND"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60 "UNIVERSAL"

DUCKBILL LOADING HEADS

Goodman Mfg. Co.

DUCKBILL LOADING HEADS, REBUILT

Leman Machine Co.

DUCT, AIR

Armco Drainage & Metal Prod., Inc.
Flexaust Co.—"FLEXAUST"
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

DUCT, BUS, ELECTRICAL

I-T-E Circuit Breaker Co.
National Electric Products Co.
Revere Copper & Brass, Inc.
Westinghouse Electric Corp.

DUCT, CABLE, ELECTRICAL

National Electric Products Co.

DUCTS, ELECTRICAL

Johns-Manville—"TRANSITE," "KORDUCT"

DUMPS, CROSSOVER, KICKBACK

C. S. Card Iron Works
The Nolan Co.

DUMPS, ROTARY, AUTOMATIC

The Nolan Co.

DUMPS, ROTARY, MINE-CAR

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Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

DUST COLLECTOR TUBES

Bemis Bro. Bag Co.

DUST COLLECTORS

Bethlehem Steel Co.
Spraying Systems Co.

DUST COLLECTORS, BAG-TYPE

The Fly Ash Arrestor Corp.

DUST COLLECTORS, DRY AND WET, SELF-CLEANING

Pangborn Corp.

DUST COLLECTORS, MECHANICAL

Buttner Works, Inc.
The Fly Ash Arrestor Corp.

DUST COLLECTORS, MECHANICAL, COAL HANDLING, PREPARATION

American Air Filter Co. Inc.
American-Standard Industrial Div.
The Ducon Co., Inc.
Joy Mfg. Co.—"JOY-MICRO-DYNE"
Kanawha Mfg. Co.
Majac, Inc., Sub. of Blackstone Corp.
McNally-Pittsburg Mfg. Corp.
Pangborn Corp.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Western Precipitation Div., Joy Mfg. Co.—"MULTICLONE"
Wheelabrator Corp.—"DUS-TUBE"

DUST COLLECTORS, MINE & DRILL

Acme Machinery Co.
American Air Filter Co. Inc.
The Ducon Co., Inc.
J. H. Fletcher & Co.
Mine Safety Appliances Co.—"DRILDUST BUCKET," "THRU-STEEL"
Schroeder Brothers Corp.

DUST COLLECTORS, VACUUM

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DUST COLLECTORS, WET TYPE

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Wheelabrator Corp.

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The Johnson-March Corp.—"CHEMJET"

DUST CONDITIONING

The Johnson-March Corp.—"VERTICONE"

DUST COUNTER

Bausch & Lomb Optical Co.

DUST COUNTS

DUST-EXCLUDER BOOTS

United States Rubber Co.—"MULTIFLEX"

DUSTPROOFING EQUIPMENT, LIQUID COMPOUNDS

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United States Rubber Co.—"USCOLITE PLASTIC"

ELECTRICAL CONTACTS, SINTERED

Stackpole Carbon Co.

ELECTRO-MECHANICAL EQUIPMENT

F. R. Hannon & Sons—"HANCO"

ELEVATOR BELTING

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
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Hewitt-Robins Incorporated
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ELEVATORS, BELT

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Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engineering Works
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engineering, Inc.
K. Prins & Associates
Republic Rubber Div., Lee Rubber & Tire Co.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
United States Rubber Co.

ELEVATORS, BUCKET

Baldwin-Lima-Hamilton Corp., Construction Equipment Div., —"LIMA AUSTIN-WESTERN"
Baughman Mfg. Co., Inc.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Fairmont Machinery Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engineering Works, Inc.
E. F. Marsh Engrg. Co. —"MARCO"
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ore Reclamation Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
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W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Universal Road Machinery Co. —"RELIANCE"
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Diesel Energy Corp.—"DEUTZ"
Harnischfeger Corp.
Homelite, a div. of Textron, Inc.—"HOMELITE"
The Lincoln Electric Co. —"WELANPOWER"
Morse Bros. Machinery Co.
Murphy Diesel Co.

Nordberg Mfg. Co.—"POWER CHIEF"
R. H. Sheppard Co., Inc.
Thor Power Tool Co.
Waukesha Motor Co.—"ENGINATORS"
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

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Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Esso Standard, Div. of Humble Oil and Refining Co.—"ESSO LUBE HDX," "ESTOR HD," "ESSOFLEET H," "DIOL RD," "ESTOR D-3"
Gulf Oil Corp.
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sun Oil Co.—"DYNAVIS," "SOLNUS," "SUNVIS"
Swan-Finch Petrochemicals

ENGINEERS

McDowell Co. Inc.
The Stearns-Roger Mfg. Co.

ENGINEERS, BLASTING VIBRATION

Vibration Measurement Engineers, Inc.

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Southwestern Engineering Co.

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Nelson L. Davis Co.
Hewitt-Robins, Incorporated
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Lippmann Engineering Works, Inc.
Meissner Engineers, Inc.
K. Prins & Associates
Robinson & Robinson, Inc.
Stephens-Adamson Mfg. Co.
Thomas Engineering & Construction Co.

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Allen & Garcia Co.
Blaw-Knox Co., Blaw-Knox Equipment Div.
The Daniels Co.
Nelson L. Davis Co.
F W D Corp.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-60
Peter F. Loftus Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Meissner Engineers, Inc.
Pierce Management, Inc.
K. Prins & Associates
Read, Davis
Robinson & Robinson, Inc.
Stephens-Adamson Mfg. Co.
Templeton-Mathews Corp.
Paul Weir Co., Inc.
WEMCO Div., Western Machinery Co.—"WKE"

ENGINEERS, CONSULTING, ELECTRICAL

Allen & Garcia Co.
Herbert S. Littlewood
Peter F. Loftus Corp.
Meissner Engineers, Inc.
National Electric Coil, Div. of McGraw-Edison Co.

ENGINEERS, CONSULTING, FLOTATION

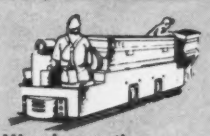
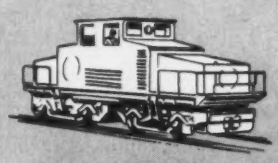
Denver Equipment Co.—"DENVER"

ENGINEERS, CONSULTING, GEOLOGY

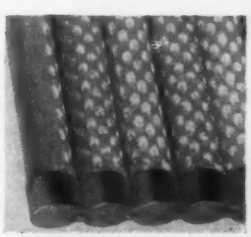
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Pennsylvania Drilling Co.
Pierce Management, Inc.
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TG	72 ah	 Shuttle cars	TLM TH	44.0 20.0
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Murphy Diesel Co.
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Hercules Motor Corp.
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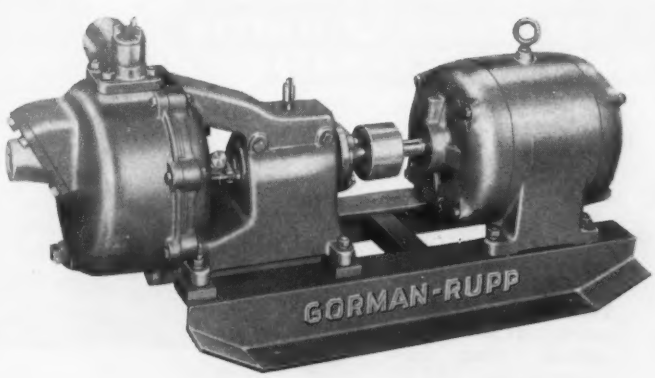
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Merrick Scale Mfg. Co.—"FEEDOWEIGHT"
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Link-Belt Co., Dept. CAMGL-60

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Link-Belt Co., Dept. CAMGL-60

FEEDERS, MINE-CAR

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Fairmont Machinery Co.
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Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Jeffery Mfg. Co.
Kanawha Mfg. Co.
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Lippmann Engineering Works
McLanahan & Stone Corp.
McNally-Pittsburgh Mfg. Corp.
E. F. Marsh Engrg. Co.—"MARCO"
Ore Reclamation Co.
Pioneer Engineering Div. of Poor & Co.
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Roberts & Schaefer Company, Division of Thompson-Starret Company, Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Transall, Inc.
Universal Road Machinery Co.—"RELIANCE"
Webster Mfg., Inc.
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FEEDERS, SCREW

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FENCING, METAL

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Filter Fabrics, Inc.
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Johns-Manville—"CELITE"
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Mine Safety Appliances Co.
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FILTER MEDIA, AIR

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Coppus Engineering Corp.
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Koppers Co., Inc., Metal Products Div.—"AERO TURN"
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Dorr-Oliver, Incorporated
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Magnetic Engr. & Mfg. Co.

FILTERS, OIL

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FILTERS, WATER

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FIRE EXTINGUISHERS

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The Fyr-Fyter Co.
Guyan Machy. Co.—"KIDDE"
Walter Kidde & Co., Inc.—"FYRE-FREEZ," "KIDDE"
National Mine Service Co.
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Swan-Finch Oil Petrochemicals—"AEROSOL"
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Ansul Chemical Co.—"ANSUL"

FIRE-FIGHTING EQUIPMENT

Cable Vulcanizing Shop, Inc.

FIRE FIGHTING EQUIPMENT, HIGH PRESSURE FOG

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

FIRE NOZZLES

Bete Fog Nozzle, Inc.

FIREPROOFING MATERIALS

Keasbey & Mattison Co.—"SPRAYED LIMPET ASBESTOS," "KAMKLAD CLOTH"

FIRE-PROTECTION SYSTEMS

American LaFrance Div. of Sterling Precision Corp.—"AL FITE CO," "FOAMITE AIRFOAM"
The Fyr-Fyter Co.
Grinnell Co.
Walter Kidde & Co., Inc.—"KIDDE CARBON DIOXIDE"

FIRE PROTECTION SYSTEMS, DRY CHEMICAL

Ansul Chemical Co.—"ANSUL"

FIRE TRUCKS, APPARATUS

American LaFrance, Div. of Sterling Precision Corp.—"AMERICAN LA FRANCE"
Ansul Chemical Co.—"ANSUL"
FWD Corp.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Mine Safety Appliances Co.

FIRST-AID EQUIPMENT

Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.—"ALL-WEATHER"
National Mine Service Co.
Pulmosan Safety Equip. Co.

FITTINGS, ALUMINUM CABLE FEEDER

The Elreco Corp.

FITTINGS, CHAIN

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
Farrell-Cheek Steel Co.

FITTINGS, GREASE

Aro Equipment Corp.
Guyan Machy. Co.—"ALEMITE"
Keystone Lubricating Co.
Stewart-Warner Corp., Alemite Div.

FITTINGS, TUBE

Parker Fittings & Hose Div., Parker-Hannifin Corp.—"FERULOK," "TRIPLE-LOK"
Weatherhead Co., Fort Wayne Div.

FITTINGS, WIRE ROPE

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
Farrell-Cheek Steel Co.

FLAME CUTTING MACHINES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.—"LINAGRAPH," "OXY-GRAPH," "TRAVOGRAPH," "DUOGRAPH," "RADIAGAPH," "CAMOGRAPH" "MONOGRAPH"

FLAME SAFETY LAMPS

Mine Safety Appliances Co.—"WOLF"
National Mine Service Co.—"KOEHLER"

FLANGE BLOCKS

Browning Mfg. Co.
Link-Belt Co., Dept. CAMGL-60

FLANGED MOUNTINGS, ANTI-FRICTION BEARING

Link-Belt Co., Dept. CAMGL-60
SKF Industries, Inc.

FLASHLIGHTS, SAFETY & INDUSTRIAL

General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.

FLEXIBLE SHAFT MACHINES, GRINDING

Martindale Electric Co.

FLIGHTS, CONVEYOR LINE

Link-Belt Co., Dept. CAMGL-60
Remaly Mfg. Co., Inc.

FLOAT & SINK TEST SOLUTIONS

American Minechem Co.—"CERTIGRAV"

FLOAT & SINK TESTERS

Commercial Testing & Engineering Co.
The Daniels Co.
Robert Holmes & Bros., Inc.

FLOCCULATING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals—Dept.—"AEROFLOC®" "SUPERFLOC 16®"
American Minechem Co.—"Minefloc"
Denver Equipment Co.
The Dow Chemical Co.—"SEPARAN"
B. F. Goodrich Chemical Co.—"GOOD-RITE K-720"
Hercules Powder Co.
Hodag Chemical Corp.

FLOODLIGHTS

Crouse-Hinds Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Homelite, a div. of Textron, Inc.—"HOMELITE"
National Mine Service Co.
Phoenix Products Co., Inc.—"STURDILITE"
Westinghouse Electric Corp.

FLOODLIGHTS, PORTABLE

Mine Safety Appliances Co.

FLOOR PLATE

Bethlehem Steel Co.
United States Steel Corp.—"USS MULTIGRIP"

FLOOR RESURFACES

Stonhard Co. Inc.—"STONPACH," "STONCAP," "STONHARD RESURFACER," "STONCLAD"

FLOORING, OPEN STEEL

Blaw-Know Co., Blaw-Knox Equipment Div.

FLOORING, WOOD BLOCK

Republic Creosoting Co.

FLOTATION CONDITIONERS

American Minechem Co.
the Daniels Co.
Denver Equipment Co.—"DENVER"
Morse Bros. Machinery Co.
WEMCO Div., Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION BROTHERS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROFROTH®"
Denver Equipment Co.—"DENVER SUB-A"
Galigher Co.—"AGITAIR"

FLOTATION LAB MACHINES

Denver Equipment Co—"DENVER SUB-A"
The Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.
WEMCO Div., Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION MACHINES

American Well Works
The Daniels Co.
Denver Equipment Co.—"DENVER SUB-A"
The Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.—"JETAIR"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
The Stearns-Roger Mfg. Co.
WEMCO Div., Western Machinery Co.—"WEMCO FAGERGREN"
Wilmot Engineering Co.

FLOTATION PLANTS, PORTABLE

The Daniels Co.
Denver Equipment Co.—"DENVER SUB-A"

FLOTATION REAGENTS

American Cyanamid Co. Explosives and Mining Chemicals Dept.—"AEROFROTH®"
American Minechem Co.—"MINEFROTH"
Denver Equipment Co.
The Dow Chemical Co.—"DOWFROTH 250"
Hercules Powder Co.
Hodag Chemical Corp.

FLOTATION TESTING LABORATORIES

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
The Galigher Co.

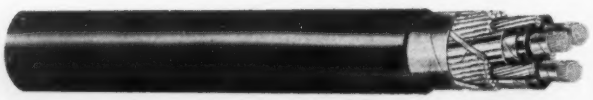
FLOW METERS

B-I-F Industries, Inc.
Fischer & Porter Co.



HIGH VOLTAGE

Rome 60 mine power cable represents the ultimate in safe design of a nonmetallic-jacketed cable. Coated copper conductors are covered with a semi-conducting tape and insulated with an ozone-resistant Rozone (oil-base) insulation compound. Rozone insulation is designed to stand up under continuous use at 75 C. Each insulated conductor is covered with a color-coded semi-conducting tape, for phase identification, and shielded throughout its entire length with a metallic shielding tape. Entire construction is covered with a reinforced Roprene (neoprene) jacket, highly resistant to acids, alkalies, oils, abrasion and flame.



Rome Type MPT mine power and feeder cable is an economical and easy-to-handle nonmetallic-jacketed power cable for mine feeder and industrial service. Insulated with polyethylene and jacketed with Roseal (flame-retardant polyethylene), it is less expensive, lighter in weight and smaller in diameter than conventional rubber and neoprene types. The insulating compound and jacket give superior resistance to most chemicals, moisture, mechanical damage and wear—important advantages for mining applications! Special construction provides long life and safety: individual conductors are strand shielded; Rolene (polyethylene) insulation on each conductor is shielded.



Rome 60 Type SH-D shielded portable power cable is designed for high-voltage operation, for use on shovels, dredges, mining machines and other similar rugged-service applications. This cable consists of 3 or 4 conductors insulated with Rozone, a high-grade ozone-resistant oil-base compound, or Rozone A butyl-base compound. A semi-conducting tape is applied over the copper conductors. The insulated conductors are covered with a color-coded tape for circuit identification. A flexible shielding braid is applied over each insulated and taped conductor, and the assembly is then covered with a reinforced jacket of mold-vulcanized neoprene (Roprene).

Before you buy another foot of mining cable, check...

Rome's guide to selecting any job in your mine

LOW VOLTAGE



Rome 60 Type W portable power cable is a round multiple-conductor made up with the specified number of flexible, color-coded insulated conductors cabled together and protected by a reinforced sheath of neoprene. This heavy-duty multiconductor portable power cable is particularly recommended for use on electric shovels, loaders, mucking machines and other equipment where delivery of a heavy power load is required. The specially compounded neoprene jacket is molded in lead to a tirelike toughness and is highly resistant to acids, alkalies, oils, abrasion and flame.



Rome 60 Type G portable power cable is similar in construction to Type W cable (see above) except that grounding conductors are placed in the interstices of the cable assembly. As with Type W and with flat twin cables, each length carries the symbol "P-105 BM" denoting compliance with Federal and Pennsylvania safety codes. All Rome 60 mining cables are insulated with a special heat-resistant rubber compound suitable for operation at 75 C., thereby providing extra overload protection. Both Type G and Type W portable power cables are available with two, three and four conductors for up to 600-volt use.



Rome 60 Flat Twin (parallel duplex) mining machine cable, for shuttle car service, features a neoprene webbing between power and grounding conductors which, unlike fibrous components, cannot rot, deteriorate or absorb moisture. The resiliency of neoprene, compared with fibrous materials, provides higher impact resistance, as well as increased protection against short circuits. Flat Twin Type W cable, without grounding conductor, is used on track-mounted equipment in ungrounded systems. Flat Twin Type G cable, with grounding conductor, is used for portable and rubber-tired equipment where grounding is required. These cables are relatively small in diameter, flexible, easy to handle and offer maximum resistance to physical abuse. Use for up to 600 volts.

cable for

ROME CABLE
DIVISION OF **ALCOA**

ROME, NEW YORK

FLUID POWER COMPONENTS
Commercial Shearing & Stamping Co. (pump generators, valve controls, motor drives, cylinder converters)

FLUIDS, HYDRAULIC — See Hydraulic Fluids

FLUX, WELDING, SALVAGE EQUIPMENT
Robert Holmes & Bros., Inc.

FOOTSPRAYERS, MATS
Onox, Inc.—"ONOX"

FORGINGS
American Chain Div., American Chain & Cable Co., Inc.
Bethlehem Steel Co.

FORGINGS, DROP
Bethlehem Steel Co.
Ladish Co.

FORGINGS, UPSET
Bethlehem Steel Co.

FREEZEPROOFING CHEMICALS
American Minechem Co.
Fuel Process Co. (Inc.)—"FU PRO CO"
Morton Salt Co.—"FORMULA 5"
Wyandotte Chemicals Corp., Michigan Alkali Div.

FREEZEPROOFING OILS
Standard Oil Co. (Ind.)

FROTHERS
American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROFROTH®"

FUEL OIL
Gulf Oil Corp.

FUELS
Pennsylvania Refining Co.

FURNACE ENCLOSURES
Bigelow-Liptak Corp.

FURNACE WALLS AND ARCHES
Geo. P. Reintjes Co.

FURNACES, AIR-HEATING
Geo. P. Reintjes Co.

FURNACES, ARCH AND WALL CONSTRUCTION
Bigelow-Liptak Corp.

FURNACES, COAL DRYING
Geo. P. Reintjes Co.

FURNACES, HEAT DRYING
Bigelow-Liptak Corp.
Robert Holmes & Bros., Inc.
Mine Smelter Supply Co.—"SKINNER"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

FURNACES, HEAT TREATING
Hevi-Duty Electric Co.

FURNACES, HEATING
E. K. Campbell Co.—"THERMIDAIRE"
Dallas Engineers Inc., Coal-O-Matic Div.—"ANTHRAFLOW," "COAL-O-MATIC"

FURNACES, LABORATORY COMBUSTION
Central Scientific Co.
Fisher Scientific Co.
Hevi-Duty Electric Co.

FURNACES, METAL-MELTING
Kuhlman Electric Co.

FURNACES, NON-FERROUS METAL MELTING
Hevi-Duty Electric Co.

FURNACES, PLANT-HEATING, DIRECT-FIRED WARM-AIR
E. K. Campbell Co.—"THERMIDAIRE"

FURNACES, WARM-AIR, HEAVY DUTY
E. K. Campbell Co.—"THERMIDAIRE"

FUSE BOXES, EXPLOSIONPROOF
Albert & J. M. Anderson Mfg. Co.

FUSE HOLDERS, BLASTING
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

FUSE HOLDERS, ELECTRICAL
Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Circuit Protective Devices Dept., General Electric Co.
Mosebach Electric & Supply Co.

FUSE REDUCERS, ELECTRICAL
Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Holub Industries, Inc.
Ideal Industries, Inc.
Trico Fuse Mfg. Co.

FUSE DETONATING
Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Memours & Co., Inc.
The Ensign-Bickford Co.—"PRIMACORD"
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

FUSE, SAFETY, BLASTING
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc.
The Ensign-Bickford Co.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.,

FUSES, ELECTRICAL
Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS," "FUSETRON"
Economy Fuse Div., Federal Pacific Electric Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"BUSSMAN"
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Trico Fuse Mfg. Co.—"TRICO"
Westinghouse Electric Corp.

GAGES, LIQUID-LEVEL
The Lunkenheimer Co.—"LUNKENHEIMER"
Nathan Mfg. Div., Wegner Machinery Corp.—"GLO ROD"

GAGES, PRESSURE, VACUUM
The Bristol Co.—"BRISTOLS"
Fischer & Porter Co.
Foxboro Co.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.

GAGES, PRESSURE, VACUUM, FLOW
Minneapolis-Honeywell Regulator Co., Industrial Div.

GAGES, TRACK
The Aldon Co.
Gibraltar Equipment & Mfg. Co.—"GEMCO TRU-BLU"
The Leetonia Tool Co.

GALVANOMETER, BLASTING
American Cyanamid Co., Explosives and Mining Chemicals Dept.
Hercules Powder Co.

GAS DETECTORS, MINE
Mine Safety Appliances Co.—"W-8 METHANE, M-6 METHANE"
National Mine Service Co.

GAS MASKS
E. D. Bullard Co.
The Fyr-Fyter Co.
Mine Safety Appliances Co.—"ALL-SERVICE"
Pulmosan Safety Equip. Co.

GASKETS & MATERIALS
Anchor Packing Co.
Garlock Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Johns-Manville—"GOETZE" "SPIROTALLIC," "SERVICE® SHEET"
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"RM"
United States Rubber Co.

GASKETS, RUBBER
Hewitt-Robins Incorporated

GASOLINE HAMMERS
Syntron Co.

GEARBELTS & PULLEYS
Browning Mfg. Co.

GEAR DRESSING
Swan-Finch Petrochemicals—"AEROSOL"

GEARMOTORS
Allis-Chalmers Mfg. Co.
The Louis Allis Co.
J. D. Christian Engineers—"RITE-LO-SPEED"
Continental Conveyor & Equipment Co.
Electro Dynamic Div. of General Dynamics Corp.
Elliott Co.
Ensign Eectric & Mfg. Co.
The Falk Corp.—"MOTOREDUCERS ALL-MOTOR"
Foote Brothers Gear & Machinery Corp.
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT," "GEARMOTORS," "MOTOGEARS"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Ore Reclamation Co.
Reliance Elec. & Eng. Co.
W. J. Savage Co.
Sterling Electric Motors, Inc., —"STERLING SLOSPEED"
Transall, Inc.
Westinghouse Electric Corp.

GEARMOTORS, RIGHT-ANGLE
Cone-Drive Gears Div., Michigan Tool Co.
Link-Belt Co., Dept. CAMGL-60

GEARS
J. D. Christian Engineers
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Flood City Brass & Electric Co.
Foote Brothers Gear & Machinery Corp.—"DUTI-RATED"
FWD Corp.
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Logan Gear Co., Inc.
Marathon Coal Bit Co. Inc.—"MARATHON," "TRACY"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.—"MICRALOY," "BRONZALOY"
Mosebach Electric & Supply Co.
North American Gear Co.—"NAMCO"
Penn Machine Co.
Pittsburgh Gear Co.
W. J. Savage Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall Inc.
Vulcan Iron Works, Inc.
West Virginia Armature Co.
Westinghouse Electric Corp.
Wilmot Engineering Co.

GEARS, MINE-LOCOMOTIVE, HEAT-TREATED
Penn Machine Co.
Farrell-Cheek Steel Co.

GEARS, PLASTIC
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
United States Rubber Co.

GEARS, REDUCTION
Link-Belt Co., Dept. CAMGL-60

GEARS, REVERSE REDUCTION
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60
Twin Disc Clutch Co.

GEARS, SEMI-STEEL
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-60
McLanahan & Stone Corp.

GEARS, WORM
Cone-Drive Gears Div., Michigan Tool Co.
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-60

GENERATOR CONTROL
Electric Machinery Mfg. Co.—"AUTO SYNCHRONIZEN"

GENERATORS
The Louis Allis Co.

GENERATORS, AC
Electric Machinery Mfg. Co.—"AMP-PAK"
Electric Products Co.

GENERATORS, AC, DC
American Marc Inc. (½ to 100-kw)
Westinghouse Electric Corp.

GENERATORS, DC
Electric Products Co.

GENERATORS, WATER WHEEL
Electric Machinery Mfg. Co.

GEOPHYSICAL SURVEYS, AIRBORNE
Fairchild Aerial Surveys, Inc.

GLOVES
American Optical Co., Safety Products Div.
Filtration Engineers Div., American Machine & Metals Inc.
General Scientific Equipment —"GS"
B. F. Goodrich Footwear and Flooring Co.—"FLEXIPRENE," "FLEXIGLUV," "GRIP-ALL," "KOROSEAL," "ARRASKYN"
Johns-Manville—"WEARBESTOS"
Mine Safety Appliances Co.—"ALL-PURPOSE"
Pulmosan Safety Equip. Co.
Riegel Textile Corp.—"RIEGEL"

GLOVES, RUBBER
Continental Rubber Works
Fisher Scientific Co.
General Scientific Equipment Co. —"GS"
Goodall Rubber Co.
B. F. Goodrich Footwear and Flooring Co.—"FLEXIPRENE," "FLEXIGLUV," "GRIP-ALL," "KOROSEAL," "ARRASKYN"
B. F. Goodrich Industrial Products Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

GLOVES, RUBBER, INDUSTRIAL
B. F. Goodrich Footwear and Flooring Co.—"FLEXIPRENE," "FLEXIGLUV," "GRIP-ALL," "KOROSEAL," "ARRASKYN"
United States Rubber Co.

GOGGLE-CLEANING STATIONS
American Optical Co., Safety Products Div.
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co. —"SAF-I-CUP"

GOGGLES
American Optical Co., Safety Products Div.
Bausch & Lomb Optical Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co. —"GS"
Marathon Coal Bit Co. Inc.—"WILSON"
Martindale Electric Co.
Mine Safety Appliances Co.—"SOFTSIDES"
Pulmosan Safety Equip. Co.
United States Safety Service Co. —"SAF-I-CUP"

GOVERNORS, COMPRESSED-AIR, UNLOADING
R. Conrader Co., Inc.—"CONRADER"

GRADER BLADES
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.

Colorado Fuel & Iron Corp.—"CF&I"
Electric Steel Foundry Co.—"ESCO"
Galion Iron Works & Mfg. Co.
The Frank G. Hough Co.

GRADERS, MOTOR

Allis-Chalmers Mfg. Co.
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER WARCO"
LeTourneau-Westinghouse Co.

GRAPHITE, LUBRICATING & GREASES

The American Oil Co.
Joseph Dixon Crucible Co.
Esso Standard, Div. of Humble Oil and Refining Co.—"VAN CAZAR," "VAN ESTAN," "VAN NAKTA"
Keystone Lubricating Co.

GRATING, FLOOR, STAIR

Dravo Corp.
Hendrick Mfg. Co.
Zurn Industries, Inc., Plumbing Products Div.—"ZURN"

GRATING, STEEL

Blaw-Knox Co., Blaw-Knox Equipment Div.

GREASE-LINE EXTENSIONS AND FITTINGS

National Mine Service Co. (Clarkson Div.)—"CLARKS"

GREASES

The American Oil Co.
Bearings, Inc.
Cities Service Oil Co.
Gulf Oil Co.
Hulburt Oil & Grease Co.
Lubriplate Div., Fiske Bros. Refining Co.—"LUBRIPLATE"
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
The Pure Oil Co.—"POCO HT-EP," "POCO GEARSHIELD," "POCO LOADER GREASE"
Sinclair Refining Co.—"LITHO-LINE," "SINCOLUBE," "PENNANT GREASES"
Texaco Inc.—"THERMATEX"

GREASES, HEAT & WATER RESISTANT

Hulburt Oil & Grease Co.
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Swan-Finch Petrochemicals

GREASES, LITHIUM BASE

Sun Oil Co.—"PRESTIGE"

GREASE, MINE CAR

Hulburt Oil & Grease Co.
Mobile Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Pennsylvania Refining Co.
Sinclair Refining Co.—"No. 217"
Sun Oil Co.

GREASES, RUST-PREVENTIVE

Sun Oil Co.

GRINDERS, BIT

Fairview Bit Co.—"FAIRVIEW AUTO-MATIC"

GRINDERS, BIT, STATIONARY

Ingersoll-Rand Co.

GRINDERS, DRILL-BIT

Herold Mfg. Co.

GRINDERS, PEDESTAL, TOOL

South Bend Lathe, Inc.

GRINDERS, PORTABLE

The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
The Cincinnati Electrical Tool Co.
Guyan Machy. Co.—"BLACK & DECKER"
Ingersoll-Rand Co.
Joseph T. Ryerson & Son, Inc.
Thor Power Tool Co.

GRINDERS, STATIONARY

The Cincinnati Electrical Tool Co.
Fisher Scientific Co.
Lippmann Engineering Works Inc.
Remington Arms Co., Inc.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.

GRINDING WHEELS

Guyan Machy. Co.—"CARBORUNDUM"
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"SIMONDS"
Minnesota Mining & Mfg. Co.—"PG"
Norton Co.—"ALUMDUM CRYSTOLON"
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"MANHATTAN"
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
United States Rubber Co.

GRINDING WHEELS, DIAMOND

Hoffman Brothers Drilling Co.
Norton Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
J. K. Smit & Sons—"SECOMET"

GRIZZLIES

Diamond Iron Works, Div. Goodman Mfg. Co.
Hammermills, Inc.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Kennedy Van Saun Mfg. & Eng. Co.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engineering Works Inc.
McNally-Pittsburg Mfg. Corp.
Nordberg Mfg. Co.—"SYMONS"
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"LIVE ROLL"
Traylor Engineering & Mfg. Co.
W. S. Tyler Co.—"Ty-ROCK," "TYLER NIAGARA"

GRIZZLIES, VIBRATING

Syntron Co.

GROUND CLAMPS

Albert & J. M. Anderson Mfg. Co.
Duquesne Mine Supply Co.
Erico Products, Inc.—"CADDY"
Mosebach Electric & Supply Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

GROUND DETECTORS

Central Mine Supply Co. Div., Pickard Industries, Inc.—"PROTECTO"
National Mine Service Co.—"GROUND SENTINEL"

GROUND INDICATORS

Schroeder Brothers Corp.

GROUND RODS

Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

GROUSER BARS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Stulz-Sickles Co.—"SSHI-C"

GROUTERS, PNEUMATIC

Mays Tunnel & Mine Equipment

GROUTING

Cement Gun Co.—"GUNITE"
Hoffman Brothers Drilling Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sika Chemical Corp.—"INTRAPLAST"

GROUTING EQUIPMENT

Sprague & Henwood

HACK-SAW BLADES

Disston Div., H. K. Porter Co. Inc.
Guyan Machy. Co.—"DISSTON"
Simonds Saw & Steel Co.—"RED END"
Snap-on Tools Corp.

HAMMERS, AIR

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Mining Progress, Inc.
Schroeder Brothers Corp.
Simonds Saw and Steel Co.
Thor Power Tool Co.
Worthington Corp.

HAMMERS, ELECTRIC

Homelite, a div. of Textron, Inc.—"HOMELITE-(BOSCH)"
Simonds Saw and Steel Co.

HAMMERS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.
Simonds Saw and Steel Co.

HAMMERS, REPLACEABLE SOFT-FACE

Snap-on Tools Corp.
Simonds Saw and Steel Co.

HANDLES, TOOL

The Leetonia Tool Co.
Marion Handle Mills, Inc.—"ACE, VIRGINIAN, A "GRADE"
The Salem Tool Co.—"BLACK DIAMOND," "PERFECT"

HANDRAIL & FITTINGS, ALUMINUM

Aluminum Co. of America

HANGERS, SHAFT—

See Shaft Hangers

HARDFACING FLUXES

The Lincoln Electric Co.—"LINCOLN WELD H535, H545 H550, H560."

HARDFACING SERVICE

American Alloy Corp.

HARD SURFACING MATERIALS

Air Reduction Sales Co., A Div. Air Reduction Co., Inc.—"AIRCOLOY," "AIRCOLITE," "R-MANG," "AIR-MANG," "TIMANG," "TUNGTUBE," "AIROD," "TEMPALLOY"
Alloy Rods Co.—"WEAR-ARC," "WEAR-FLAME," "WEAR-O-MATIC WIRE"
American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
Ampco Metal, Inc.—"AMPCO TRODE"
Coast Metals, Inc.
Crucible Steel Co. of America—"REXWELD®"
Eutectic Welding Alloys Corp.—"EUTECHROMS" "TOOLTECTIC," "INSTANT HARDENER"
International Nickel Co., Inc.
The Lincoln Electric Co.—"ABRASOWELD," "MANGANWELD," "JET-HARD BU 90," "FACEWELD," "SURFACEWELD," "STAINWELD," "TOOLWELD," "WEARWELD," "MANGJET"
Marathon Coal Bit Co. Inc.—"AIRCO"
Metal & Thermit Corp.—"HARDEX"
Rexarc, Inc.—"REXARC"
Stoody Co.—"STOODY"
Stulz-Sickles Co.—"SEACO"
Taylor-Wharton Co. Div. Harsco Co.—"TIMANG"
Wall Colmonoy Corp.—"COLMONOY"

HAULAGES, R. R. CAR BOAT

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60

HAULERS—See "Trucks, off-highway"

HAULING UNITS

Athey Products Corp.

HAUL'NG UNITS, RUBBER TIRED

Athey Products Corp.

HAULS, CAR

Link-Belt Co., Dept. CAMGL-60

HEADLIGHTS

Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Guyan Machy. Co.—"GUYAN"
Imperial-Cantrell Mfg. Co.—"I. C."
Jeffrey Mfg. Co.

HEADLIGHTS, MINE LOCOMOTIVE

Schroeder Brothers Corp.

HEATER, PANEL & UNITS

United States Rubber Co.—"USKON"

HEATERS, OIL

Dravo Corp.
Hauck Mfg. Co.

HEATERS, UNIT

American Air Filter Co., Inc.
American-Standard Industrial Div.—"VENTURAFIN"
Buffalo Forge Co.—"BUFFALO"
E. K. Campbell Co.—"THERMIDAIRE"
Clarage Fan Co.
Dravo Corp.
Grinnell Co.
Ilg Electric Ventilating Co.—"ILG"
Westinghouse Electric Corp., Sturtevant Div.
L. J. Wing Mfg. Co. Div. of Aero Supply Mfg. Co. Inc.—"WING REVOLVING"

HEATING CABLE, LEAD-SHEATHED

Rockbestos Wire & Cable Co., Inc., Div. of Cerro de Pasco Corp.

HEATING PLANTS

Axeman-Anderson Co.
Dravo Corp.

HEAVY-MEDIA RECLAMATION SYSTEMS

The Daniels Co.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Denver Equipment Co.—"DECO"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Mine and Smelter Supply Co.—"AKINS"
Simplicity Engineering Co.
WEMCO Div., Western Machinery Co.—"WEMCO"

HEAVY-MEDIA SEPARATION PROCESS

The Daniels Co.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Dravo Corp.
Fairmont Machinery Co.
Fuel Process Co. (Inc.)
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Mine and Smelter Supply Co.—"AKINS"
K. Prins & Associates
Robert & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sterna Magnetic Products
WEMCO Div., Western Machinery Co.—"WEMCO MOBILMILL"

HEAVY-MEDIA SEPARATORS

Hardinge Co., Inc.
Link-Belt Co., Dept. CAMGL-60

HEEL BLOCKS, SWITCH

Bethlehem Steel Co.

HIGH-VOLTAGE TESTING EQUIPMENT

F. R. Hannon & Sons—"HANCO"

HINGES, MINE-DOOR

National Mine Service Co. (Clarkson Div.)—"CLARKSON"

HITCHINGS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Duquesne Mine Supply Co.
Enterprise Wheel and Car Corp.
Irwin-Sensenich Corp.
National Malleable & Steel Castings Co.
Sanford Day Iron Works, Inc.

HOIST CONTROLLERS

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Morse Bros. Machinery Co.

HOIST HOOKS

Bethlehem Steel Co.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY—LAUGHLIN"
Duquesne Mine Supply Co.
The Upson-Walton Co.

HOIST SIGNALLING COMMUNICATION

Femco, Inc.—"CAGE-PHONE"
Industrial Physics & Electronics Co.
Mine Safety Appliances Co.—"HOISTPHONE"



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TRACK SWITCH THROWER ELECTRICALLY OPERATED

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HOISTS, AIR

Aro Equipment Corp.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc. Shaw-Box Crane & Hoist Div. —"BUDGIT," "LOAD LIFTER'
Shepard Niles Crane & Hoist Corp.
Thor Power Tool Co.
Yale & Towne Mfg. Co.

HOISTS, CONSTRUCTION

American Hoist & Derrick Co.
Chicago Pneumatic Tool Co.

HOISTS, ELECTRIC

American Engineering Co.— "LO-HED"
Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"QUICK-LIFT"
Columbus McKinnon Chain Corp., Mining Equipment Div.— "LODESTAR"
Guyan Machy. Co.—"SHAW-BOX"
Harnischfeger Corp.
Robert Holmes & Bros., Inc.,
Hewitt-Robins Incorporated
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. —"BUDGIT," "LOAD LIFTER"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Sanford Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.
The Stearns-Roger Mfg. Co.
Stephens-Adamson Mfg. Co.
Vulcan Iron Works Co. (Denver) —"VULCAN-DENVER"
Vulcan Iron Works, Inc.
Yale & Towne Mfg. Co.—"MIDGET KING," "CABLE KING," "LOAD KING"

HOISTS, ELECTRIC AND GASOLINE

Clyde Iron Works, Inc.

HOISTS, FRICTION TYPE

Nordberg Mfg. Co.

HOISTS, GASOLINE

Joy Mfg. Co.

HOISTS, HAND

J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"SAFETY PULL," "SUPER POWER"
Columbus McKinnon Chain Corp., Mining Equipment Div.
Denver Equipment Co.— "DENVER"
Harnischfeger Corp.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. —"BUDGIT," "TUGIT," "SHAW BOX"
Morse Bros. Machinery Co.
Ore Reclamation Co.
Robbins & Myers, Inc —"R & M"
Joseph T. Ryerson & Son, Inc.
Stephens-Adamson Mfg. Co.
Yale & Towne Mfg. Co.—"PULLIFT," "LOAD KING"

HOISTS, LAYER-LOADING

Robert Holmes & Bros., Inc.
Sanford Day Iron Works, Inc.

HOISTS, LOADING-BOOM

Morse Bros. Machinery Co.
Robert & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sanford Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, MONORAIL

American Engineering Co.— "LO-HED"
Coffing Hoist Div., Duff-Norton Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. —"BUDGIT," "TUGIT," "SHAW BOX"
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, PORTABLE

Aro Equipment Corp.
Chicago Pneumatic Tool Co.
Coffing Hoist Div., Duff-Norton Co.
Denver Equipment Co.— "DENVER"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"BUDGIT"
Harnischfeger Corp.
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc. Shaw-Box Crane & Hoist Div. —"BUDGIT," "TUG-IT," "SHAW BOX"
Robbins & Myers, Inc.—"R & M"
Ruger Equipment, Inc.
Joseph T. Ryerson & Son, Inc.
Schroeder Brothers Corp.
Shepard Niles Crane & Hoist Corp.
Yale & Towne Mfg. Co.—"LOAD KING"

HOISTS, SCRAPER

American Hoist & Derrick Co. —"AMERICAN"
Ingersoll-Rand Co.
Joy Mfg. Co.
Sauerman Bros., Inc.

HOISTS, SHAFT

Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. —"SHAW-BOX"
Mayo Tunnel & Mine Equipment —"KOEPE"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works, Inc.
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

HOISTS, SHAFT, FRICTION-TYPE

Connellsville Mfg. & Mine Supply Co.

HOISTS, SKIP

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60

HOISTS, SLOPE

Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works, Inc.
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

HOISTS, TRUCK-BODY

Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marion Metal Products Co.
Perfection Steel Body Co.
Tulsa Winch Div. of Vickers, Inc.

HOLDBACKS, CONVEYOR

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60
Stephens-Adamson Mfg. Co.

HOPPERS—See Bins & Hoppers, Coal, Storage & Blending

HOPPER LOADERS, UNDERGROUND

The Eimco Corp.

HOPPERS, WEIGH

Industrial Physics & Electronics Co.
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.

HOSE, AIR

Acme-Hamilton Mfg. Corp.
Acme Machinery Co.
Aeroquip Corp.
Anchor Coupling Co., Inc.
Aro Equipment Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Continental Rubber Works— "VITAULIC," "LIBERTY" "TRIBUNE," "ENDURO"
The Eimco Corp.
The Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"COMMANDER," "TYPE 88," "TYPE 50," "MAXEGON ALL PURPOSE"
Goodyear Tire & Rubber Co.
Guyan Machinery Co.
Hewitt-Robins Incorporated— "MONARCH," "AJAX," "HEWITT," "MALTESE CROSS"
Joy Mfg. Co.
Lincoln Engrg. Co. Div. of McNeil Mach. & Engrg. Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TOWER"
Schroeder Brothers Corp.
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
Thor Power Tool Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, AIR-SHOOTING

Aeroquip Corp.
Central Mine Supply Div., Pickard Industries, Inc.—"SEAL-TITE"
Long-Airdox Co.

HOSE, COAL WASHING

B. F. Goodrich Industrial Products Co.—"CONVERTAPIPE"

HOSE, CONDUIT

Guyan Machy. Co.

HOSE, FIRE

Acme-Hamilton Mfg. Corp.
American LaFrance, Div. of Sterling Precision Corp.—"AMERICAN LA FRANCE," "GOODYEAR"
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
The Fyr-Fyter Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"PINNACLE," "COMMANDER," "SOLAR," "MAINSTAY," "CASCADE," "B.F.G. SIGNAL"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated— "AJAX," "MONARCH," "MALTESE CROSS"
Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC 600"
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE, FLEXIBLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Compton, Inc.
Farris Flexible Valve Corp.— "FLEX VALVE," "SUPER SEAL"
Flexaust Co.— "FLEXAUST"
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, FLEXIBLE METAL

Cobra Metal Hose, Div. DK Mfg. Co.

HOSE, FLEXIBLE, MINE

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
The Eimco Corp.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CONVERTA-PIPE"

Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.
Thermoid Co.

HOSE, GAS

Hewitt-Robins Incorporated
Paltech Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

United States Rubber Co.

HOSE, GASOLINE

B. F. Goodrich Industrial Products Co.—"TYPES 72, 72-A, 72-W PUMP HOSE," "TYPE 79 & 82-A TANK HOSE" "TYPES 83 & 83-A FUEL OIL HOSE"
Hewitt-Robins Incorporated

HOSE, GREASE & OIL

Aeroquip Corp.
Aro Equipment Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Lincoln Engrg. Co. Div. of McNeil Mach. & Engrg. Co.
Raybestos Manhattan Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Stewart-Warner Corp., Alemite Div.
Thermoid Co.
Weatherhead Co., Fort Wayne Div.

HOSE, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Blackhawk Industrial Div.
Carlyle Rubber Co., Inc.
Central Mine Supply Co., Div., Pickard Industries, Inc. —"SEALTITE"
Champ Industries, Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.—"EASTMAN"
Hewitt-Robins Incorporated
Mining Machine Parts, Inc.
National Mine Service Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"WIRETEX"
Schroeder Brothers Corp.
Stewart Warner Corp., Alemite Div.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, INDUSTRIAL

Dayton Industrial Products Co.—"DAYTON"

HOSE, ROCK-DUST

American Mine Door Co.
B. F. Goodrich Industrial Products Co.—"DUSTEX"
Hewitt-Robins Incorporated
Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

HOSE, STEAM

Acme-Hamilton Mfg. Corp.
Aeroquip Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.
United States Rubber Co.

HOSE, SUCTION, DISCHARGE

Acme-Hamilton Mfg. Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CASCADE," "MAXECON," "MORECON," "SPIROLOCK," "TYPE 81 FOR WATER," "TYPES 400, 200, 150, 100, FOR OIL," "TYPE 82-A FOR GASOLINE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE, WATER

Acme-Hamilton Mfg. Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co.
Gering Plastics, div. of Studebaker Packard Corp.—"GERING (T-M)"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"JUPITER DELUGE ALARM"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"MONARCH," "AJAX," "HEWITT"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Ore Reclamation Co.
Plymouth Rubber Co. Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TONKA"
Thermoid Co.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE ASSEMBLIES, SPLIT FLANGE

Anchor Coupling Co. Inc.

HOSE CLAMPS

Chicago Pneumatic Tool Co.
Hose Accessories Co.
Marman Div., Aeroquip Corp.

HOSE FITTINGS

Aeroquip Corp.—"SOCKETLESS" "LITTLE GEM," "SUPER GEM"
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Hose Accessories Co.
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Long-Airdox Co.
Mining Machine Parts, Inc.
Parker Fittings & Hose Div., Parker Hannifin Corp.—"HOZE-LOK"
Schroeder Brothers Corp.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, DETACHABLE & REUSABLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Continental Rubber Works
Goodall Rubber Co.
Hewitt-Robins Incorporated
Hose Accessories Co.
Hunt Valve Co.—"QUIK-AS-WINK"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—"LOKTITE"
Mining Machine Parts, Inc.
Parker Fittings & Hose Div., Parker Hannifin Corp.—"HOZE-LOK," "PUSH-LOK"
Schroeder Brothers Corp.

NEW PRIMER
for Ammonium Nitrate-Oil BLASTING AGENT



Actual size — 3" diameter, 2" high
(Patent Applied For)

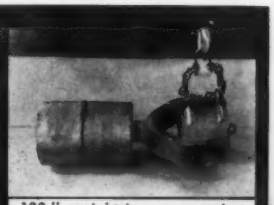
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The SAF-T-BOOST primer, Model No. 151, withstands unusually rugged treatment without detonating (a fact that will save many a shovel dipper). SAF-T-BOOST's high detonation velocity . . . *over 20,000 feet per second* . . . puts out power-plus for high-order detonation of ammonium nitrate-fuel oil blasting agents. Initiation is positive. SAF-T-BOOST is non-headache producing, non-freezing, and economical. Primacord sensitive only when threaded.

SAF-T-BOOST is normaliy used with 50-grain initiating cord down lines—yet lends itself readily to blast hole decking. *Write*

NOW AVAILABLE
IMMEDIATE DELIVERY

PROPELLEX
CHEMICAL DIVISION CHROMALLOY CORPORATION
P. O. BOX 187, EDWARDSVILLE, ILLINOIS
PHONE EDWARDSVILLE 3400



130-lb weight is swung against SAF-T-BOOST taped to a steel block. In over 100 tests, SAF-T-BOOST did not detonate.



30-lb. weight is dropped from height of 40 feet onto SAF-T-BOOST taped to steel plate. In this test, SAF-T-BOOST has never detonated.



SAF-T-BOOST is placed on wood excelsior and ignited. SAF-T-BOOST burns completely without detonating.

Thermoid Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Champ Industries, Inc.
Compton, Inc.
Continental Rubber Works
Goodall Rubber Co.
Hose Accessories Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Schroeder Brothers Corp.
Stewart-Warner Corp., Alemite Div.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, SWAGED

Weatherhead Co., Fort Wayne Div.

HOSE & TUBE COMBINATIONS

Anchor Coupling Co., Inc.

HYDRAULIC ACCUMULATORS

Bethlehem Steel Co.
Parker Hydraulics Div., Parker-Hannifin Corp.—"PARKER"
Schroeder Brothers Corp.

HYDRAULIC CONTROL UNITS

Caterpillar Tractor Co.
Megator Corp.—"MEGATOR" CONFLOW"

HYDRAULIC CYLINDERS

Bethlehem Steel Co.
Blackhawk Industrial Div.
Joy Mfg. Co.
Ledeen, Inc.
Schroeder Brothers Corp.
Star Hydraulics, Inc.
Vickers Incorporated

HYDRAULIC CYLINDERS, PUMPS, VALVES, REBUILT

Leman Machine Co.

HYDRAULIC FLUID

The American Oil Co.
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Esso Standard, Div. of Humble Oil and Refining Co.—"TERESSO," "ESSTIC," "NUTO," "NURAY," "CORAY," "UNIVIS"
Hulburt Oil & Grease Co.
Keystone Lubricating Co.
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sinclair Refining Co.—"DURO"
Sun Oil Co.—"SOLNUS," "SUNTAC," "SUNVIS" "MINETAC," "SUNVIS" "MINESAFE" (new)
Texaco, Inc.—"RECAL OIL R&O

HYDRAULIC FLUIDS, FIRE-RESISTANT

Monsanto Chemical Co.—"PYDRAUL SERIES"
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.—"SHELL 3XF MINE FLUID"
Swan-Finch Petrochemicals

HYDRAULIC POWER UNITS

Schroeder Brothers Corp.

HYDRAULIC PUMPS

American Engineering Co.—"HELE-SHAW," "HYRA-MITE"
Blackhawk Industrial Div.
Compton, Inc.
Denison Engineering Div., American Brake Shoe Co.
Gar Wood Industries, Inc.
General Equipment & Manufacturing Co.
Hydreco Div., The New York Air Brake Co.—"HYDRECO"
Joy Mfg. Co.
National Mine Service Co.
Schroeder Brothers Corp.
Star Hydraulics, Inc.
Vickers Incorporated
Worthington Corp.

HYDRAULIC PUMPS, REBUILDING, REPAIR

Meckum Engineering, Inc.
West Virginia Armature Co.

HYDRAULIC REPAIR SERVICE

Flood City Brass & Electric Co.

HYDRAULIC SYSTEMS CENTRAL

Aldrich Pump Co.

HYDRAULIC VALVES

Blackhawk Industrial Div.
A. W. Cash Co.
Denison Engineering Div., American Brake Shoe Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hydreco Div., New York Air Brake Co.—"HYDRECO"
Ledeen, Inc.
The Lunkenheimer Co.—"LUNKENHEIMER"
Parker Hydraulic Div., Parker-Hannifin Corp.—"PARKER"
Schroeder Brothers Corp.
Vickers Incorporated
Walworth Co.

HYDROSEPARATORS

Bird Machine Co.
Denver Equipment Co.—"DENVER," "HYDRO-CLASSIFIER"
Dorr-Oliver, Incorporated
Hardinge Co., Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company Inc.
WEMCO DIV., Western Machinery Co.—"WEMCO"

IMPACT TOOLS—See Drills, Roof-Bolting, Rotary Impact Tools for

INDICATING LIGHTS

Cutler-Hammer, Inc.—"PRES-TEST"

INDICATING LIGHTS, OILTIGHT

Cutler-Hammer, Inc.

INDICATORS, REMOTE

Allis-Chalmers Mfg. Co.
B-I-F Industries, Inc.
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Hewitt-Robins Incorporated
Industrial Physics & Electronics Co.

INDICATORS, SIGHT-FEED AND WATER

The Lunkenheimer Co.—"LUNKENHEIMER"

INDICATORS, SPEED, ELECTRIC

Reliance Electric and Eng. Co.

INDICATORS, TEMPERATURE

West Instrument Corp—"VERITELL"

INITIATORS, AMMONIUM NITRATE-FUEL-OIL BLASTING AGENTS

Propellex Chemical Div., Chromalloy Corp.—"SAF-T-BOOST"

INSTRUMENTS, BLASTING-VIBRATION

W. F. Sprengnether Instrument Co., Inc.

INSTRUMENTS, FLOW-INDICATING

New Jersey Meter Co., Inc.—"FLO-SIG," "TOOL-OM-ETER" "DRILL-O-METER"

INSTRUMENTS—HYDRAULIC CIRCUIT TESTING

Schroeder Brothers Corp.

INSTRUMENTS, RECORDING PRESSURE, TEMPERATURE, ETC.

B-I-F Industries, Inc.—"FLO-WATCH," "CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
Hays Corp.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
West Instrument Corp.—"MARKSMAN"

INSTRUMENTS, ROOF-CONTROL

Herold Mfg. Co.

INSULATING MATERIALS, ELECTRICAL

Dow Corning Corp.
Duquesne Mine Supply Co.
General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept.
Irvington Div. of Minnesota Mining & Mfg. Co.
Johns-Manville—"FIBROID" "ARMATURO," "QUINTERRA," "QUINTERRABORD" "QUINORGO," "QUINORGOBORD" "ASBESTOS "EBONY," "OHMSTONE"
Keasbey & Mattison Co.
Minnesota Mining & Mfg. Co.—"SCOTCHFIL," "SCOTCH CAST BRAND RESIN"
National Electric Coil Div. of McGraw-Edison Co.
Pennsylvania Electric Coil Corp.
Shell Oil Co.
West Virginia Armature Co.

INSULATING MATERIALS, HEAT & COLD

Bigelow-Liptak Corp.
Philip Carey Mfg. Co.—"MAGNESIA," "HI-TEMP," "CAREY-TEMP," "AIRCELL," "IMPERVO," "PERFECTO"
Johns-Manville—"SUPEREX," "ASBESTO-SPONGE," "THERMOBESTOS," "ROCK CORK," "ZEROLITE," "FIBROCEL" "THERMOFLEX," "ASBESTOCEL," "SPINTEX," "BANROC" "MICROLITE" "MICROTEX," "MICRO-LOK," "METAL-ON"
Keasbey & Mattison Co.
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"PLASTIC," "VEE-BLOCK CASTABLE," "M-5," "I-R-C"
Pittsburgh Corning Corp.—"FOAMGLAS"
Pittsburgh Plate Glass Co.—"PPG FIBER GLASS" "SELETROFOAM"
The Ruberoid Co.
United States Rubber Co.

INSULATING MATERIALS, NOISE

Johns-Manville—"SPIN COUSTIC," "SANACOUSTIC," "PERMACOUSTIC," "FIBRETONE," "MICRO-BAR," "PANELGLAS," "MICROLITE"
Keasbey & Mattison Co.—"SPRAYED LIMPET," "ASBESTOS"
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND"
Pittsburgh Plate Glass Co.—"PPG FIBRE GLASS" "SELETROFOAM"
United States Rubber Co.

INSULATING MATERIALS, THERMAL

Dow Corning Corp.

INSULATORS

Albert & J. M. Anderson Mfg. Co.

INSULATORS, ELECTRIC

The Elreco Corp.
Ohio Brass Co.

INSULATORS, H. V.

Delta-Star Electric Div., H. K. Porter Co., Inc.

INSULATORS, PORCELAIN

I-T-E Circuit Breaker Co.

INSULATORS, RUBBER

Automatic Vulcanizing Corp.

INSULATORS, SECTION

The Elreco Corp.—"ELRECO"

INSURANCE, CASUALTY, WORKMEN'S COMPENSATION

Bituminous Casualty Corp.
J. B. Pfister Co.
Reliance Insurance Co.

INSURANCE, PLANT & EQUIPMENT

J. B. Pfister Co.
Reliance Insurance Co.

INSURANCE, SELF PROGRAMS

J. B. Pfister Co.

INTERCOOLERS, COMPRESSOR

American-Standard Industrial Div.

INVERTERS & CONVERTERS

Cornell-Dubilier Electronics Div., Federal Pacific Electric Co.—"POWERCONS"
Perkin Engineering Corp. (DC to AC)

INVESTMENT BANKERS

Dominick & Dominick

INVESTMENT GUIDANCE

F. S. Smithers & Co.

IRON OXIDE

Foote Mineral Co.—"MAGNA-FLOAT"

J-HOOKS, INSULATED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"

J-HOOKS, NON-INSULATED

The Elreco Corp.—"ELRECO"

JACKLEGS, PNEUMATIC

Chicago Pneumatic Tool Co.
Schroeder Brothers Corp.

JACK-PIPE

Duquesne Mine Supply Co.

JACKS, AIR-OPERATED

Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co.—"REMO-TROL"

JACKS, ANCHOR OR HOLD DOWN

Templeton, Kenly & Co.

JACKS, BELT-TENSIONING

Templeton, Kenly & Co.—"SIMPLEX"

JACKS, ELECTRICALLY OPERATED

Templeton, Kenly & Co.—"REMOTROL"

JACKS, GASOLINE-OPERATED

Templeton, Kenly & Co.—"REMOTROL"

JACKS, GEARED

Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, HYDRAULIC

Aro Equipment Corp.
Blackhawk Industrial Div.
Duff-Norton Co.
National Mine Service Co.
H. K. Porter, Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, MECHANICAL

Blackhawk Industrial Div.

JACKS, PULLING

Armstrong, Bray & Co.—"STEELGRIP"
Duff-Norton Co.
Gibraltar Equipment & Mfg. Co.
Joyce Cridland Co.
National Mine Service Co.
The Nolan Co.
Star Hydraulics, Inc.
Templeton, Kenly & Co.—"JENNY," "CENTER-HOLE"
Transall, Inc.

JACKS, PUSH & PULL

Armstrong, Bray & Co.—"STEELGRIP"
Blackhawk Industrial Div.
Duff-Norton Co.
Gibraltar Equipment & Mfg. Co.
Joyce Cridland Co.
National Mine Service Co.
H. K. Porter, Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, RACHET LIFTING, LOWERING

Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.—"SIMPLEX"
National Mine Service Co.

JACKS, RACHET LOWERING

Templeton, Kenly & Co.—"SIMPLEX"

JACKS, REEL

Templeton, Kenly & Co.—"SIMPLEX"

JACKS, ROOF

Duff-Norton Co.
Duquesne Mine Supply Co.
Herold Mfg. Co.
Mining Progress, Inc.
National Mine Service Co.
Templeton, Kenly & Co.—"SIMPLEX"
Vulcan Iron Works, Inc.

JACKS, ROOF, HYDRAULIC

Templeton, Kenly & Co.—"SIMPLEX"

JACKS, ROOF BOLT RECOVERY

Templeton, Kenly & Co.—"SIMPLEX"

JACKS, SCREW

Duff-Norton Co.
Joyce Cridland Co.
Ensign Electric & Mfg. Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, TIMBERING

Duff-Norton Co.
Ensign Electric & Mfg. Co.
Herold Mfg. Co.
Mining Progress, Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, TRACK

Templeton, Kenly & Co.

JETS, OVERFIRE, SMOKE CONTROL

Canton Stoker Corp.—"TURBO-AIRE"

JIG SAWS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.

JIGS, PYRITE RECOVERY

Denver, Equipment Co.—"DENVER," "SELECTIVE MINERAL"

JOINT COMPOUND, ALUMINUM CABLE

The Elreco Corp.

JOINTS, EXPANSION, RUBBER, TEFLON

Garlock Inc.

JOINTS, HIGH PRESSURE AND TEMPERATURE

Marman Div., Aeroquip Corp.—"LIVE JOINT"

JOINTS, SWIVEL

Chiksan Co.

JOURNAL BOXES, REBUILT

Leman Machine Co.

JOURNALS, BOXES

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Chain Belt Co.—"REX"
Enterprise Wheel and Car Corp.
Flood City Brass & Electric Co.
Helmick Foundry-Machine Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
West Virginia Armature Co.

JUNCTION BOXES ELECTRIC, STRIPPING

Atkinson Armature Works
Crouse-Hinds Co.
Joy Mfg. Co.

JUNCTION BOXES, ELECTRIC, UNDERGROUND

Albert & J. M. Anderson Mfg. Co.—"POW-R-GARD," "GROUND-GARD"
Crouse-Hinds Co.
Ensign Electric & Mfg. Co.
Joy Mfg. Co.
National Electric Products Co.
Ohio Brass Co.
Schroeder Brothers Corp.

KNEE PADS

General Scientific Equipment Co.—"GS"
Judsen Rubber Works, Inc.
Mine Safety Appliances Co.
Mining Progress, Inc.
National Mine Service Co.
Pulmosan Safety Equip. Co.

KNOCK OUT PUNCHES, HYDRAULIC

Blackhawk Industrial Div.

KW, KWRA, KVA, RKVA METERS

The Bristol Co.—"BRISTOL'S"
Westinghouse Electric Corp.

LABORATORY EQUIPMENT

Bausch & Lomb Optical Co.
Central Scientific Co.
Denver Equipment Co.—"DENVER"
Fischer & Porter Co.
Fisher Scientific Co.
The Galigher Co.
Robert Holmes & Bros., Inc.
Laboratory Equipment Corp.—"LECO"
Sturtevant Mill Co.
W. S. Tyler Co.

LABORATORY EQUIPMENT, COAL DRYING

Link-Belt Co., Dept. CAMGL-60

LABORATORY GLASSWARE

Fischer & Porter Co.—"LABREST"

LABORATORY TESTING

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
The Galigher Co.
Southwestern Engineering Co.—"SWECO"
Sturtevant Mill Co.
Wemco Div., Western Machinery "WEMCO"

LACING, BELT

Armstrong-Bray & Co.—"STEELGRIP," "SAFETY," "WIREGRIP"
Crescent Belt Fastener Co. (Plates & Rivets)—"CRESCENT"
General Splice Corp.—"MINET"

LADDERS, AERIAL

Delta-Star Electric Div., H. K. Porter Co., Inc.

LAMPS, INCANDESCENT AND FLUORESCENT

National Mine Service Co.

LAMPS, PICKING

General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Mosebach Elec. & Supply Co.

LARRIES

Chain Belt Co.—"REX"
Connellsville Mfg. & Mine Supply Co.
Irwin Sensenich Corp.
Link-Belt Co., Dept. CAMGL-60
Stephens-Adamson Mfg. Co.

LARRIES, WEIGH

Link Belt Co., Dept. CAMGL-60

LATEX

B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated

LATHES

Farrell-Birmingham Co., Inc.
South Bend Lathe, Inc.

LEADING WIRE

Hercules Powder Co.

LEVELS, ENGINEERS

C. L. Berger & Sons, Inc.—"BERGER"
Gurley, W. & L. E.
Kern Instruments, Inc.

LEVELS, ROD

Kern Instruments, Inc.

LEVELS, TRACK

The Aldon Co.

LIGHTING, EMERGENCY

American Optical Co., Safety Products Div.—"SENTRY-LITE"
Exide Industrial Div., The Electric Storage Battery Co.—"EXIDE LIGHTGUARD"

LIGHTING, PORTABLE, PREFABRICATED

Joy Mfg. Co.—"STRING-O-LITE"

LIGHTING FIXTURES

Crouse-Hinds Co.
Ideal Industries, Inc.
Phoenix Products Co., Inc.
Westinghouse Electric Corp.

LIGHTING FIXTURES, UNDERGROUND

Femco, Inc.
Mine Safety Appliances Co.—"M-S-A FLUORESCENT"

LIGHTING SETS, LOW-VOLTAGE

Joy Mfg. Co.

LIGHTNING ARRESTERS

Delta-Star Electric Div., H. R. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
Ohio Brass Co.
Westinghouse Electric Corp.

LIGHTNING ARRESTERS, HIGH-VOLTAGE

Ohio Brass Co.—"THOREX"

LIGHTS, VAPOR-TIGHT, PORTABLE FLUORESCENT

Day-Ray Products, Inc.—"DAY-RAY"

LINER PLATE, CHUTES CONVEYORS, ETC.

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Armco Drainage & Metal Prod., Inc.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates

LINER PLATE, SHAFT & TUNNEL

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Republic Steel Corp.—"TRUSCON"

LININGS, CHUTE, CERAMIC

Bigelow-Liptak Corp.

LININGS, CHUTE & FLUME

Linco Co.
Stonhard Co. Inc.—"STONPACH"

LININGS, CHUTE, GLASS

Pittsburgh Plate Glass Co.—"CARRARA"

LININGS, CHUTE, METAL

American Manganese Steel Div., American Brake Shoe Co. "AMSCO"
The Daniels Co.
Enterprise Wheel and Car Corp.
Illinois Zinc Co.
Kanawha Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Laubenstein Mfg. Co.
Remaly Mfg. Co., Inc.
Stulz-Sickles Co.—"MANGANAL"

LININGS, CHUTE, RUBBER

Acme-Hamilton Mfg. Corp.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BOSTON"
The Galigher Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Linatex Corp. of America
Magic Chemical Co.—"MAGIC-VULC IRON RUBBER"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.
United States Rubber Co.

LININGS, CHUTE, RUBBER, PLAIN & METAL BACKED

B. F. Goodrich Industrial Products Co.

LININGS, CONCRETE

Bigelow-Liptak Corp.
Cement Gun Co.—"GUNITE"
Sika Chemical Corp.—"PLASTIMENT CONCRETE DENSIFIER"

LININGS, FURNACE

Bigelow-Liptak Corp.
Cement Gun Co.—"GUNITE"
Joseph Dixon Crucible Co.
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.

LININGS, PNEUMATIC CONCRETE

Cement Gun Co.—"GUNITE"

LININGS, SHEET, CONCRETE AND STEEL

Amercoat Corp.—"AMERPLATE" "T-LOCK AMERPLATE"

LININGS, TANK

Cement Gun Co.—"GUNITE"
Linco Co.

LININGS, TANK FLUORCARBON

Garlock Inc.

LININGS, TANK, GLASS

Pittsburgh Plate Glass Co.—"CARRARA & HERCULITE"

LININGS—TANK, METAL

Enterprise Wheel and Car Corp.

LININGS, TANK, RUBBER

Denver Equipment Co.—"DENVER"
The Galigher Co.
The Gates Rubber Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Linatex Corp. of America
Magic Chemical Co.—"MAGIC-VULC"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.
United States Rubber Co.

LININGS, VINYL SHEET

A. M. Byers Co.

LINKS, INSULATED SAFETY

E. D. Bullard Co.

LIQUIDS, REFLECTIVE

Minnesota Mining & Mfg. Co.—"CODITBRAND"

LOAD SUSPENSION, RUBBER, MINE CARS

National Malleable & Steel Castings Co.

LOADERS, BUCKET

Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"

LOADERS, FRONT-END

The Eimco Corp.
Euclid Div., General Motors Corp.

LOADERS, PORTABLE, BELT, BUCKET

Barber-Greene Co.
Gruendler Crusher & Pulverizer Co.
Irwin-Sensenich Corp.
Kremser & Sons, Inc., Frank A.
Lippmann Engineering Works Inc.
Pettibone Mulliken Corp., Haiss Div.
Stephens-Adamson Mfg. Co.

LOADERS, REVOLVING, CRAWLER

Koehring Div. of Koehring Co.

LOADERS, SELF PROPELLED BELT

Athey Products Corp.
Link-Belt Co., Dept. CAMGL-60—"JETSLINGERS"

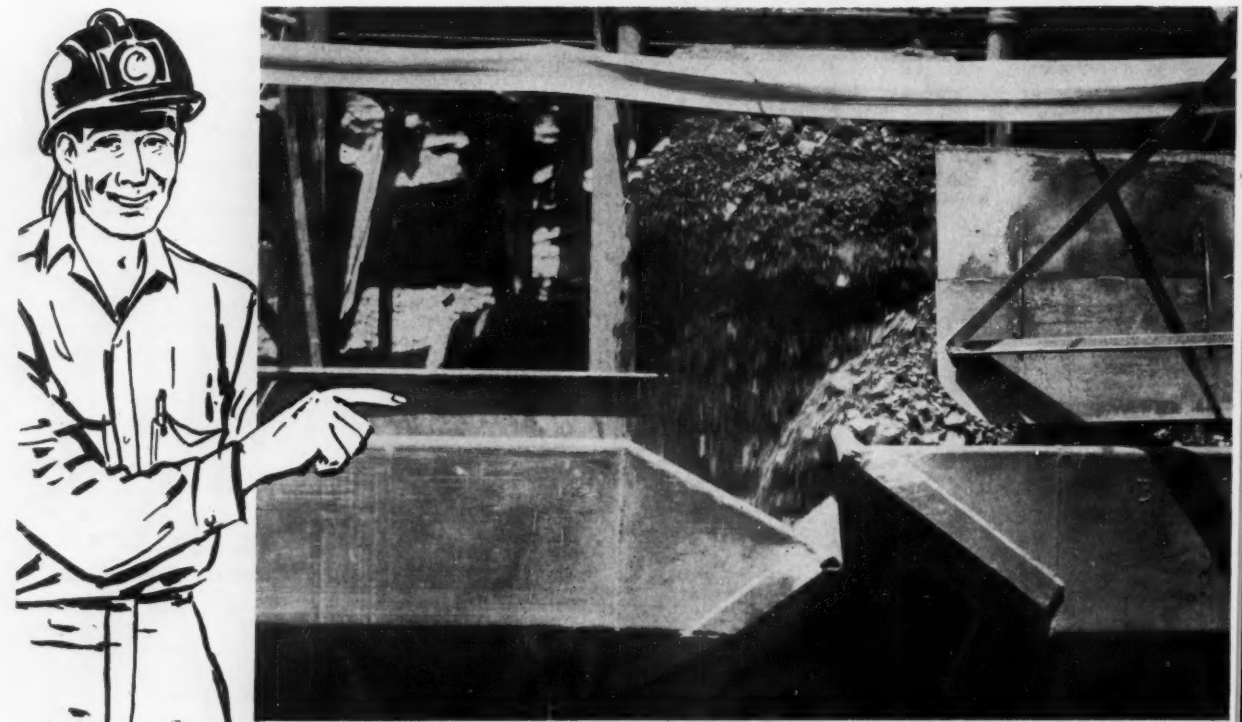
LOADERS, SHOVEL-TYPE, CRAWLER

Allis-Chalmers Mfg. Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.—"LIMA"
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.—"TRAXCAVATORS"
The Eimco Corp.
Insley Manufacturing Corp.
International Harvester Co.—"SKID-SHOVEL"
Koehring Div. of Koehring Co.
Mining Progress, Inc.
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"

LOADERS, SHOVEL-TYPE, RUBBER-TIRED

Caterpillar Tractor Co.—"TRAXCAVATORS."
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"

"Here, in unretouched pictures, why S-D Automatic 'Overlapping haulage cost to the

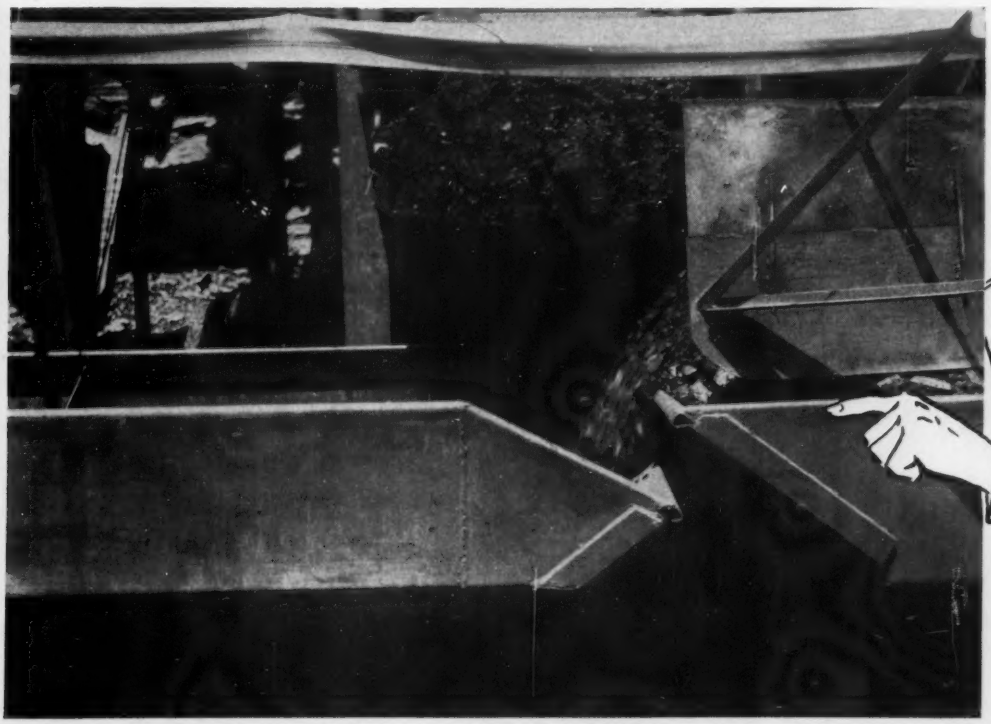


Note coal continues to flow from chute directly over exclusive S-D Automatic "Overlapping Ends" — without spillage between-cars. Photographer shot this picture while trip was in-movement.

This still-shot shows the Top Dresser Bar and Side Dresser Plate, which automatically dress the cars as they are automatically loaded!



is shown one of the basic reasons End' Cars will reduce your absolute minimum..."





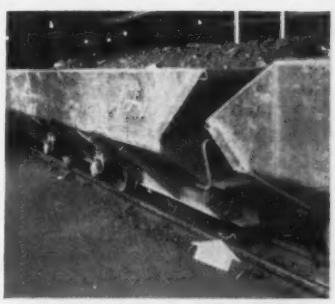
We had chute discontinue loading at the moment this picture was shot so you could see that in actual operation two things take place: (1) as mentioned, flow of coal continues uninterrupted and also (2) after dressing car to underground haulageway height, surplus coal is plowed into next car in trip—thanks to S-D "Overlaping Ends."

EVERY YEAR, without exception, more mines convert to the S-D Automatic Car Haulage System. What are the reasons?

1. Since the mining operation at the face and the preparation of coal for shipment are separate and distinct functions, operators want them to be carried on independently, so that each may operate in the most economcial manner . . . in other words, so that no interruption or slow down in one will interrupt or slow down the other. They want the system that will continuously remove coal from the loading point as it is mined, and, at the same time, will provide a continuous supply for the preparation plant. Automatic Bottom Dumping Mine Cars are the only known means of low cost coal mine transportation that will allow a continuous movement of coal from the face, or loading point, to the railroad car. Reason for this is because these cars are the only method of haulage that can use a low cost, low maintenance, large capacity SURGE BIN, which serves as a temporary storage for coal in transit and thereby balances the mining and preparation operations.

2. Lower initial capital cost — 40% fewer cars required . . . fewer locomotives . . . rotary dump requires special dump at high cost . . . cleaning plant may be of smaller capacity because it does not have to handle all the coal as quickly as it is mined.

3. Lower operation cost — fewer cars, fewer locomotives . . . no rotary dump to operate and maintain . . . no dumping labor, and with S-D "Overlapping End" Cars no loading labor!



Automatic Dumping ON-THE-MOVE!

4. Greater flexibility — cars of any size and dimension can be dumped over same SURGE BIN, provided each has same track gauge, of course. Double tracks can be used over bin where desirable. No tilting chutes or other similar mechanisms required at loading points; therefore, less headroom and less capital cost, plus minimum time required for moving loading set-up! No other coal haulage system gives the flexibility provided by Automatic Bottom Dumping Car Transportation!

These are some of the fundamental reasons why the S-D Automatic Bottom Dumping Car Haulage System reduces cost to the absolute minimum. How much can you save? We recommend a fact-finding survey by our Application Field Engineer. No obligation, of course. May we get together? Write or call us today!

Sanford-Day Iron Works, Inc., Knoxville, Tenn.

SANFORD-DAY

KNOXVILLE, TENNESSEE

The Frank G. Hough Co.—"PAYLOADER"
Insley Manufacturing Corp.
Koehring Div. of Koehring Co.
Sanford Day Iron Works, Inc.—"TRANS-LOADER"
The Thew Shovel Co.—"LORAIN MOTO-LOADER"

LOADERS, TRACTORS

Allis-Chalmers Mfg. Co.
J. I. Case Co.—"CASE"
The Eimco Corp.
International Harvester Co.
The Oliver Corp.—"OLIVER"

LOADERS, TRACTOR-MOUNTED

Allis-Chalmers Mfg. Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
The Eimco Corp.
Goodman Mfg. Co.
Hyster Co.
International Harvester Co.
Joy Mfg. Co.
Machinery Center, Inc.
Morse Bros. Machinery Co.

LOADERS, TRACTOR-MOUNTED REBUILT

Leman Machine Co.

LOADING BOOMS, APRON

Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Company Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co. Inc.

LOADING BOOMS, BELT

Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.
Thomas Engineering & Construction Co.
Webster Mfg. Co. Inc.

LOADING BOOMS, CHAIN

Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Webster Mfg. Co. Inc.

LOADING BOOMS, CHAIN RESCREENING

Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

LOADING-MACHINE CHECKS

Daly Ticket & Printing Co.—"DALY'S"

LOADING MACHINES, REBUILT

Leman Machine Co.

LOADING MACHINES, UNDERGROUND, CRAWLER

The Eimco Corp.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Long-Airdox Co.—"MODEL 88," "MODEL 188"
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"

LOADING MACHINES, UNDERGROUND, RUBBER-TIRED

Jeffrey Mfg. Co.
National Mine Service Co.—"CLARKSON"

LOADING MACHINES, UNDERGROUND, CONVERTED TRACK TO RUBBER

Lee-Norse Co.

LOADING MACHINES, UNDERGROUND, TRACK-MOUNTED

The Eimco Corp.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Mining Progress, Inc.
Myers-Whaley Co.—"WHALEY AUTOMAX"

LOADING STICKS, LOCK-HOOK

G. R. Johnson Loading Supplies

LOCATORS, TRAILING-CABLE FAULT

General Equipment & Manufacturing Co.
Ohio Brass Co.

LOCKERS

Republic Steel Corp.—"REPUBLIC STEEL"

LOCKERS, OVERHEAD

The Moore Co.—"LOCKERBASKETS"

LOCKERS, STEEL

Miners Hardware Supply Co.—"LYON METAL PRODUCTS"

LOCK NUTS

Bearings, Inc.
Elastic Stop Nut Corp. of America—"ELASTIC STOP NUTS"
Link-Belt Co., Dept. CAMGL-60
National Electric Products Co.
The Palnut Co.—"PALNUT"
Republic Steel Corp.—"REPUBLIC NYLOK"

LOCOMOTIVES, AIR

The Eimco Corp.

LOCOMOTIVES, BATTERY

General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
The Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Kersey Manufacturing Co., Inc.
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.
Morse Bros. Machinery Co.

LOCOMOTIVES, CABLE-REEL

General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.

LOCOMOTIVES, DIESEL-ELECTRIC

Differential Steel Car Co.
Fairbanks Morse & Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH"

LOCOMOTIVES, DIESEL HYDRAULIC

General Electric Co., Locomotive & Car Equipment Dept.

LOCOMOTIVES, DIESEL, SURFACE

Brookville Locomotive Works
Diesel Energy Corp.—"DEUTZ"
Fairbanks Morse & Co.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQOMOTIVE"

LOCOMOTIVES, DIESEL, UNDERGROUND

Diesel Energy Corp.—"DEUTZ"
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.
National Mine Service Co.—"GREENSBURG"
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH MINE-O-MOTIVE"

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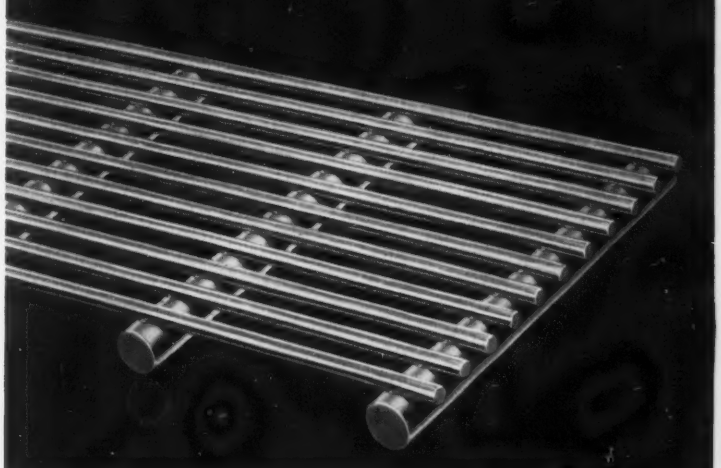
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PARTS, SHUTTLE CAR

Cooke-Wilson Electrical Supply Co.
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kelly Mfg. Co., Machine Parts Div.
National Mine Service Co.
Penn Machine Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, TRUCK

C. S. Card Iron Works
Hendrickson Mfg. Co.
KW-Dart Truck Co.

PARTS, WEARING, TRACTORS & EARTHMOVERS

Interstate Equipment Corp.

PENTAPRISMS, (RIGHT-ANGLE) (SINGLE & DOUBLE)

Kern Instruments, Inc.

PH INDICATORS

Analytical Measurements, Inc.
The Bristol Co.—"BRISTOL's"
Fisher Scientific Co.
Foxboro Co.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Scientific & Process Instruments Div., Beckman Instruments, Inc.

PHOTOCOPY EQUIPMENT, MATERIALS

Peerless Photo Products, Inc.—"DRI-STAT" "QUICK SILVER"

PHOTO MOSAICS

Aero Service Corp.
American Air Surveys, Inc.

PICKING TABLES

Carrier Conveyor, div. Chain Belt Co.—"CARRIER NATURAL FREQUENCY"
Fairmont Machinery Co.
Heyl & Patteron, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-60
E. F. Marsh Engrg. Co.—"MARCO"
Morse Bros. Machinery Co.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Wilmot Engineering Co.

PICKS

The Bowdel Co.
Gibraltar Equipment & Mfg. Co.
The Leetonia Tool Co.

PILING

Republic Creosoting Co.

PILING, TREATED, UNTREATED

T. J. Moss Tie Co.

PILLOW BLOCKS

Browning Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
New Departure Div., General Motors Corp.

PILLOW BLOCKS, ANTIFRICTION-BEARING

Ahlberg Bearing Co.—"AHLBERG"
Bearings, Inc.
Chain Belt Co.—"SHAFER"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SC-SCM-SLP," "SPHER-ALIGN"
The Fafnir Bearing Co.
Guyan Machy. Co.—"SEAL-MASTER"
Hewitt-Robins Incorporated—"JONES"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT," "JPS," "MILLBEARING," "SPHERICAL"
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Transall, Inc.
Wilmot Engineering Co.

PILLOW BLOCKS, SLEEVE-BEARING

Bearings, Inc.
Chain Belt Co.—"REX"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SLEEVOIL"
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT," "JPS," "MILLBEARING," "SPHERICAL"
K. Prins & Associates
Transall, Inc.
Wilmot Engineering Co.

PINIONS

Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-60

PIPE, ALUMINUM

Aluminum Company of America—"ALCLAD," "UNI-STRENGTH"
Guyan Machy. Co.
Kaiser Aluminum & Chemical Sales Co.
Revere Copper & Brass Inc.
Reynolds Metals Co.

PIPE, ASBESTOS-CEMENT

Guyan Machy. Co.—"TRANSITE"
Johns-Manville—"TRANSITE"
Keasbey & Mattison Co.
Midland Pipe & Supply Co.—"TRANSITE"

PIPE, BITUMINIZED FIBER

Triangle Conduit & Cable Co., Inc.

PIPE, BRONZE

Ampco Metal, Inc.

PIPE, CARBIDE-COATED

American Alloy Corp.

PIPE, CAST-IRON

United States Pipe & Foundry Co.
Wilmot Engineering Co.

PIPE, CEMENT-LINED

Jones & Laughlin Steel Corp.
United States Pipe & Foundry Co.

PIPE, COPPER, RED BRASS

Phelps Dodge Copper Products Co.
Revere Copper & Brass Inc.
Triangle Conduit & Cable Co., Inc.

PIPE, CORROSION-RESISTANT

Duriron Co., Inc.

PIPE, CORRUGATED

Armco Drainage & Metal Prod., Inc.
Republic Steel—"REPUBLIC"

PIPE, DRIVE, AND DRIVING WINCHES

Acker Drill Co. Inc.—"MODEL RG and RGT"

PIPE, IRRIGATION, ALUMINUM

Aluminum Company of America
Reynolds Metals Co.

PIPE, PLASTIC

Amercoat Corp.—"BOND-STRAND"
A. M. Byers Co.
Carlon Products Corp.
Crane Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Guyan Machy. Co.
Johns-Manville Plastics Corp.—"DUR-X"
Johnson Plastic Corp.—"KRALASTIC"
Midland Pipe & Supply Co.
National Mine Service Co.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son Inc.
Thermoid Div., H. K. Porter Co., Inc.
Triangle Conduit Cable Co., Inc.
United States Rubber Co.
Yardley Plastics Co.—"CLEARSTREAM"
The Youngstown Sheet and Tube Co.—"FIBERCAST"

PIPE, PLASTIC, FLEXIBLE

Irvington Div. of Minnesota Mining & Mfg. Co.

PIPE, RUBBER

Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Linatex Corp. of America
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"CONDOR"
United States Rubber Co.

PIPE, RUBBER-LINED

Farris Flexible Valve Corp.—"FLEXVALVE," "SUPER SEAL"
The Galigher Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Naylor Pipe Co.
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"CONDOR"
United States Rubber Co.

PIPE, SEAMLESS

Bethlehem Steel Co.
Phoenix Steel Corp., Structural & Tube Divs.

PIPE, SLUDGE

Naylor Pipe Co.

PIPE, SPIRAL-WELDED

Armco Drainage & Metal Prod. Inc.
Midland Pipe & Supply Co.
Naylor Pipe Co.

PIPE, STAINLESS STEEL

Allegheny Ludlum Steel Corp.—"ALLEGHENY"
National Tube Div., United States Steel Corp.—"USS"

PIPE, STEEL

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Jones & Laughlin Steel Corp.
Midland Pipe & Supply Co.
National Supply Company—"SPANG"
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
The Youngstown Sheet and Tube Co.—"YOLOY"

PIPE, STEEL, PLASTIC-COATED

Republic Steel

PIPE, STEEL, STAINLESS & HIGH ALLOY

Crucible Steel Co. of America—"TRENTWELD®"

PIPE, STEEL WELDED

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Jones & Laughlin Steel Corp.
Koven Fabricators, Inc.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
The Youngstown Sheet and Tube Co.

PIPE, WOOD

Peter O. Sutphen Co.

PIPE, WOOD-STAVE

Peter O. Sutphen Co.

PIPE, WROUGHT-IRON

A. M. Byers Co.
Midland Pipe & Supply Co.
Wilmot Engineering Co.

PIPE CLAMPS

Marman Div., Aeroquip Corp.

PIPE COUPLINGS

Dresser Mfg. Div., Dresser Industries, Inc.—"DRESSER®"

PIPE COUPLINGS, FLEXIBLE

Victaulic Co. of America—"VICTUALIC"

PIPE COUPLINGS, GROOVED

Dresser Mfg. Div., Dresser Industries, Inc. — "KUPL-LOK," "TM"
Eastern Sales Co., Div. of Eastern Malleable Iron Co.—"ALUMIRON"

PIPE COVERINGS

Philip Carey Mfg. Co.—"CAREYTEMP" "AIRCELL," "IMPERVO," "PERFECTO."
The Galigher Co.
Gustin-Bacon Mfg. Co.—"SNAP-ON"
Johns-Manville—"TRANTEX," "TRANSHIELD," "DURA-MESH," "DURATAPE," "BLUE FLAG," "DURAMAT"
Pittsburgh Corning Corp.—"STAY-DRY," "FOAMGLAS"
The Ruberoid Co.

PIPE FABRICATION

Dravo Corp.
The Stearns-Roger Mfg. Co.

PIPE FITTINGS

Anchor Coupling Co., Inc.
Armco Drainage & Metal Prod., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Eastern Sales Co., Div. of Eastern Malleable Iron Co.—"ALUMIRON CORVEL 51"
The Fairbanks Co.—"DART"
Grinnell Co.
Gustin-Bacon Mfg. Co.
Guyan Machy. Co.—"GRINNEL," "VICTAULIC"
McDowell Mfg. Co.
Midland Pipe & Supply Co.
Naylor Pipe Co.
United States Pipe & Foundry Co.
Victaulic Co. of America—"VICTAULIC"
Walworth Co.
Weatherhead Co., Fort Wayne Div.

PIPE FITTINGS, BRASS

Grinnell Co.

PIPE FITTINGS, BRONZE

Ampco Metal, Inc.
Walworth Co.

PIPE FITTINGS FLANGES—PLASTIC & WELDED

Midland Pipe & Supply Co.
United States Rubber Co.
Walworth Co.

PIPE FITTINGS FLANGES—WELDING

Tube Turns Div. of Chemetron Corp.

PIPE FITTINGS, FORGED STEEL

Bethlehem Steel Co.
Ladish Co.

PIPE FITTINGS, PVC-LINED

Victaulic Co. of America

PIPE FITTINGS, PLASTIC

Carlon Products Corp.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Grinnell Co.
Johns-Manville Plastics Corp.—"DUR-X"
Johnson Plastic Corp.
Midland Pipe & Supply Co.
National Mine Service Co.
Republic Steel—"REPUBLIC"
Inc.
Triangle Conduit & Cable Co.
United States Rubber Co.
Victaulic Co. of America
Walworth Co.
The Youngstown Sheet and Tube Co.

PIPE FITTINGS, RUBBER

United States Rubber Co.

PIPE FITTINGS, STAINLESS-STEEL

Electric Steel Foundry Co.
Victaulic Co. of America

PIPE FITTINGS, STEEL & ALLOYS

Ladish Co.

PIPE FITTINGS, WROUGHT-IRON

A. M. Byers Co.

PIPE FLANGES, FORGED, STAINLESS, ALLOYS

Bethlehem Steel Co.
Ladish Co.

PIPE GROOVERS

Gustin-Bacon Mfg. Co.—"ROLL-A-GROOVE," "BEAVER"
Victaulic Co. of America—"VIC-GROOVER," "VI-EASY"

PIPE HANGERS

Grinnell Co.

PIPE PROTECTION, EXTERIOR AND INTERIOR

Pipe Linings, Inc.—"SOMASTIC®" "TATE," "SPUNLINE®," "CENTERLINE"

PIPE-REPAIR, CLAMPS, SLEEVES

Dresser Mfg. Div., Dresser Industries, Inc.—"HANDI-BAND®"

PIPE TOOLS

The Ridge Tool Co.—"RIDGID"
Toledo Pipe Threading Machine Co.

PIPEWALL-THICKNESS GAGES

Industrial Nucleonics Corp.—"ACCURAY"

PIPING SYSTEMS, FABRICATION WELDING

The Galligher Co.
Grinnell Co.
Midland Pipe & Supply Co.

PISTON RINGS

Koppers Co., Inc. Metal Products Div.—"AMERICAN HAMMERED INDUSTRIAL"

PIT PROPS, STEEL YIELDING AND RIGID

Mining Progress, Inc.

PLANERS

Farrel-Birmingham Co., Inc.

PLANERS, COAL

Mining Progress, Inc.

PLASTIC SHEETS, PLATE, PIPE

Joseph T. Ryerson & Son, Inc.

PLATE, ALLOY

Bethlehem Steel Co.
Crucible Steel Co. of America
Jones & Laughlin Steel Corp.—"JALLOY"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Revere Copper & Brass Inc.
United States Steel Corp.—"USS CARILLOY," "USST-1," "USS FC"
The Youngstown Sheet and Tube Co.

PLATE, ALLOY, CARBON & STAINLESS STEEL

A. M. Byers Co.

PLATE, FLOOR

Jones & Laughlin Steel Corp.—"JAL-THREAD," "JUNIOR JAL-THREAD"
Kanawha Mfg. Co.

PLATE, STEEL

Bethlehem Steel Co.
A. M. Byers Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"CLAYMONT"
Crucible Steel Co. of America
The Daniels Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Phoenix Steel Corp., Structural & Tube Divs.
W. J. Savage Co.
Stulz-Sickles Co.—"MANGANAL"
United States Steel Corp.
The Youngstown Sheet and Tube Co.

PLATE, STEEL, STAINLESS

Allegheny Ludlum Steel Corp.—"ALLEGHENY"
A. M. Byers Co.

PLATE, WROUGHT IRON

A. M. Byers Co.

PLATE & SHEET, ALUMINUM

Aluminum Company of America
Kanawha Mfg. Co.
Reynolds Metals Co.

PLATE & SHEET, ZINC

Illinois Zinc Co.

PLIERS, ELECTRICIANS

Snap-On Tools Corp.

PLUGS & RECEPTACLES, EXPLOSIONPROOF

Albert & J. M. Anderson Mfg. Co.

PLUGS & RECEPTACLES, HIGH & LOW CURRENT & VOLTAGE

Albert & J. M. Anderson Mfg. Co.
Crouse-Hinds Co.
Joy Mfg. Co.
Ohio Brass Co.
United States Rubber Co.

POLE-LINE MATERIALS

Duquesne Mine Supply Co.
I-T-E Circuit Breaker Co.
Mosebach Electric & Supply Co.

POLES, PRESSURE-CREOSOTED

Koppers Co., Inc., Wood Preserving Div.

POLES, TELEPHONE & TELEGRAPH

Republic Creosoting Co.

POLES, TREATED

T. J. Moss Tie Co.

POLES, TROLLEY

Duquesne Mine Supply Co.

POLISHERS, REFUSE-REMOVAL FROM WATER

Bird Machine Co.

POLLUTION-CONTROL SYSTEMS

B-I-F Industries, Inc.
Bird Machine Co.
Denver Equipment Co.—"DENVER"
Dorr-Oliver Incorporated
Heyl & Patterson, Inc.
Industrial Physics & Electronics Co.
Link-Belt Co., Dept. CAMGL-60

POLLUTION-CONTROL SYSTEMS, AIR

American Air Filter Co., Inc.

POLYETHYLENE-FILM SHEETING & TUBING

Gering Plastics, div. of Studebaker-Packard Corp.—"GERPAK" (T.M.)

PORTABLE BREAKERS

Athey Products Corp.

POST-HOLE DIGGERS

The Wood Shovel & Tool Co.

POSTERS, MINE SAFETY

Elliott Service Co., Inc.

POSTS, STEEL FENCE

American Steel & Wire, U. S. Steel Corp.—"AMERICAN"
Bethlehem Steel Co.

POSTS, TREATED

T. J. Moss Tie Co.

POTHEADS
G & W Electric Specialty Co.

POWDER BAGS—
SEE Bags, Powder

POWDER STORAGE, FIELD UNITS
Atlas Powder Co.
Dravo Corp.
E. I. du Pont de Nemours & Co., Inc.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

POWDERED METAL PARTS
Keystone Carbon Co.

POWER DIVIDERS
Tulsa Winch Div. of Vickers, Inc.—"TULSA"

POWER-FACTOR METERS, RECORDERS
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
Westinghouse Electric Corp.

POWER STEERING GEARS, HYDRAULIC
R. H. Sheppard Co., Inc.

POWER TOOLS, ELECTRIC
Disston Div., H. K. Porter Co., Inc.

POWER TRANSMISSION EQUIPMENT
Hewitt-Robins Incorporated

POWER UNITS, GASOLINE, DIESEL
Hercules Motors Corp.

POWER UNITS, HYDRAULIC
Denison Engrg. Div., American Brake Shoe Co.
Vickers Incorporated
Tulsa Winch Div. of Vickers, Inc.

PREPARATION BUILDERS, CONTRACTORS
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-60
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Southwestern Engineering Co.
Wilmot Engineering Co.

PREPARATION PLANTS, PORTABLE
The Daniels Co.—"DMS"
Robert Holmes & Bros., Inc.
K. Prins & Associates
Thomas Engineering & Construction Co.
WEMCO Div., Western Machinery Co.—"WEMCO MOBIL-MILL"

PRESSES, HYDRAULIC
Bethlehem Steel Co.
Blackhawk Industrial Div.
Denison Eng'g. Div. American Brake Shoe Co.
Farrel-Birmingham Co., Inc.

PRIMER INITIATORS—See Initiators, Ammonium Nitrate—Fuel Oil Blasting Agents

PROPS—See Roof Support

PULLERS, FUSE
Economy Fuse Div., Federal Pacific Electric Co.
Holub Industries, Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"TRICO"

PULLERS, GEAR & WHEEL
Armstrong-Bray & Co.—"STEELGRIP"
Bearings, Inc.
Hewitt-Robins Incorporated
Martindale Electric Co.
The Nolan Co.
Snap-on Tools Corp.
Templeton, Kenly & Co.—"SIMPLEX"

PULLERS, GEAR & WHEEL, HYDRAULIC
Armstrong-Bray & Co.—"HYDRAGRIP"
Bearings, Inc.
Blackhawk Industrial Div.
Templeton, Kenly & Co.—"RE-MO-TROL"

PULLEYS, CAST IRON
Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McLanahan & Stone Corp.
Transall, Inc.
Webster Mfg., Inc.
T. B. Woods Sons Co.

PULLEYS, CONVEYOR — SEE Conveyor Belt Idlers, Conveyor-Belt Idler Pulleys

PULLEYS, MOTOR
Reeves Pulley Co., Div. The Reliance Electric & Engrg. Co.—"VARI-SPEED"

PULLEYS, PAPER
Browning Mfg. Co.

PULLEYS, RUBBER-COVERED
General Splice Corp.—"MINET" "COLDBOND"
United States Rubber Co.

PULLEYS, SEMI-STEEL
Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated
McLanahan & Stone Corp.
Webster Mfg., Inc.
T. B. Woods Sons Co.

PULLEYS, STEEL
The American Pulley Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.— "TAPER-LOCK"
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-60—"DIE-CROWN"
E. F. Marsh Engrg. Co.—"MARCO"
W. J. Savage Co.
Sprout, Waldron & Co., Inc.—"BELTSAVER"
Transall, Inc.

PULLEYS, WOOD
J. D. Christian Engineers

PULVERIZER PARTS, MANGANESE STEEL
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

PULVERIZERS, COAL
American Pulverizer Co.
Hardinge Co., Inc.
Jeffrey Mfg. Co.

PULVERIZERS, FURNACE-FEED
Combustion Engineering, Inc.—"C-E-RAYMOND"
Foster Wheeler Corp.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Majac Inc., Sub. of Blackstone Corp.
Williams Patent Crusher & Pulv. Co.

PULVERIZERS, LABORATORY
American Pulverizer Co.
Combustion Engineering, Inc.—"C-E-RAYMOND"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Mine and Smelter Supply Co.—"MASSCO MCCOOL"
Sturtevant Mill Co.
Williams Patent Crusher & Pulv. Co.

PUMPING STATIONS
Acker Drill Co. Inc.

PUMP CONTROLS
Flygt Corp.

PUMP-PRIMING EQUIPMENT
Barrett, Haentjens & Co.
Flood City Brass & Electric Co.
Goyne Pump Co.
Nash Engineering Co.

PUMPS, AIR-DRIVEN
Chicago Pneumatic Tool Co.
Emglo Products Corp.—"EMGLO"
M. Glosser & Sons Inc.

PUMPS, AIR-HYDRAULIC
Ledeen Mfg. Co.

PUMPS, ASH (WATER JET)
Canton Stoker Corp.—"WAG-ENER"

PUMPS, CENTRIFUGAL
The Allen-Sherman-Hoff Pump Co.
Allis-Chalmers Mfg. Co.
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American-Marsh Pumps, Inc.
American Well Works
Ampco Metal, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.—"BUFFALO"
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.—"REX"
Chicago Pneumatic Tool Co.
Construction Machy. Co.
Dean Brothers Pumps Inc.
The Deming Co.
Dorr-Oliver, Incorporated
The Duriron Co., Inc.
Emglo Products Corp.—"EMGLO"
Ensign Electric & Mfg. Co.
Fairbanks Morse & Co.
Flood City Brass & Electric Co.
Flygt Corp.—"FLYGT"
Gardner-Denver Company
M. Glosser & Sons, Inc.
The Gorman-Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
Guyan Machy. Co.—"GORMAN RUPP," "MYERS"
Homelite a div. of Textron, Inc.—"HOMELITE"
Ingersoll-Rand Co.
Johnston Pump Co., Div. of the Youngstown Sheet and Tube Co.
LaBour Co., Inc.
Lancaster Pump & Mfg. Co.—"UNIT PUMP TYPE M"
Marlow Pumps, Div. of Bell & Gossett Co.
McNally-Pittsburg Mfg. Corp.
Morris Machine Works
Nagle Pumps, Inc.
National Mine Service Co.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Pennsylvania Pump & Compressor Co.—"THRUSTFRE"
Rice Pump & Machine Co.—"RICE"
Roots-Connersville Blower, Div. Dresser Industries Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, CENTRIFUGAL REBUILT
Leman Machine Co.

PUMPS, CENTRIFUGAL SELF-PRIMING
American Well Work
Barnes Mfg. Co.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.—"REX"
Chicago Pneumatic Tool Co.
Construction Machinery Co.
The Deming Co.
The Duriron Co., Inc.
Ensign Electric & Mfg. Co.
Flygt Corp.—"FLYGT"
The Gorman-Rupp Co.
Goulds Pumps, Inc.
Guyan Machy. Co.—"GORMAN RUPP"
Homelite a div. of Textron, Inc.—"HOMELITE"
Ingersoll-Rand Co.
LaBour Co., Inc.—"HYDRO-BALANCE"
Lancaster Pump & Mfg. Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Nagle Pumps, Inc.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Rice Pump & Machine Co.—"RICE"
Worthington Corp.

PUMPS, CORROSION-RESISTANT
The Duriron Co., Inc.
Flygt Corp.
Johnston Pump Co., Div. of the Youngstown Sheet and Tube Co.
A. R. Wilfley & Sons

PUMPS, DEEP WELL
The Deming Co.
Layne & Bowler Pump Co.—"VERTI-LINE"
Layne & Bowler, Inc.—"LAYNE"

PUMPS, DIAPHRAGM
Barnes Mfg. Co.
B-I-F Industries, Inc.—"CHEM-O-FEEDER," "ADJUSTO-O-FEEDER," "PROPORTIO-EER"
Carver Pump Co.
Chain Belt Co.—"REX"
Construction Machy. Co.
Denver Equipment Co.—"DEN-VER ADJUSTABLE STROKE"
Dorr-Oliver, Incorporated
The Eimco Corp.
Gardner-Denver Company
The Gorman-Rupp Co.
Homelite a div. of Textron, Inc.—"HOMELITE"
Guyan Machy. Co.—"GORMAN RUPP"
Marlow Pumps, Div. of Bell & Gossett Co
Morse Bros. Machinery Co.
Ore Reclamation Co.
Rice Pump & Machine Co.—"RICE"
WEMCO Div., Western Machinery Co.—"WEMCO"

PUMPS, DRUM
Aro Equipment Corp.
General Scientific Equipment Co.—"GS"
Gray Co., Inc.—"DIRECT-FROM-DRUM"
Lincoln Engrg. Co, Div. of McNeil Mach. & Engrg. Co.—"AIRLINE"

PUMPS, FIRE
Allis-Chalmers Mfg. Co.
Flood City Brass & Electric Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Layne & Bowler Pump Co.—"VERTI-LINE"
Porto Pump, Inc.
Rice Pump & Machine Co.—"RICE"

PUMPS, FROTH HANDLING
Denver Equipment Co.—"DEN-VER"
A. R. Wilfley & Sons

PUMPS, HIGH PRESSURE
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

PUMPS, HIGH VACUUM
Central Scientific Co.—"CEN-CO HYVAC"

PUMPS, HORIZONTAL-SHAFT
Nagle Pumps, Inc.

PUMPS, JETTING
Barnes Mfg. Co.
Construction Machy. Co.
The Deming Co.
Fairbanks Morse & Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Lancaster Pump & Mfg. Co.—"DUTCHMAN"
Porto Pump, Inc.

PUMPS, METERING
B-I-F Industries, Inc.
Roots-Connersville Blower, Div. Dresser Industries Inc.

PUMPS, OIL
Canton Stoker Corp.—"WAG-ENER"

PUMPS, PISTON & PLUNGER
American-Marsh Pumps, Inc.
Canton Stoker Corp.—"WAG-ENER"
Dean Brothers Pumps Inc.
The Deming Co.
Flood City Brass & Electric Co.
Gardner-Denver Company
Goulds Pumps, Inc.
Guyan Machy. Co.—"MYERS"
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Co.

Lancaster Pump & Mfg. Co — "GIANT," "LITTLE GIANT"
Ledeen Mfg. Co.
National Mine Service Co.
National Supply Company— "NATIONAL"
Worthington Corp.

PUMPS, PLUNGER

Aldrich Pump Co.

PUMPS, PORTABLE SLUDGE AIR

Chicago Pneumatic Tool Co.
Herold Mfg. Co.

PUMPS, PRESSURE-TESTING

Porto Pump Inc.

PUMPS, PRIMING

Kenco Pump Div., American Crucible Products Co

PUMPS, RADIAL PISTON

American Engineering Co.— "HELE-SHAW," "HYRA-MITE"

PUMPS, ROTARY

The Deming Co.
Flygt Corp.—"FLYGT"

PUMPS, ROTARY PISTON GEAR

Kinney Vacuum Div., The New York Air Brake Co.

PUMPS, SAND ABRASIVE HANDLING

Allis-Chalmers Mfg. Co.
Denver Equipment Co.—"DENVER S-R-L"
Johnston Pump Co., Div. of the Youngstown Sheet and Tube Co.
A. R. Wilfley & Sons

PUMPS, SOLIDS-HANDLING

The Allen-Sherman-Hoff Pump Co. — "HYDROSEAL-CENTRISEAL"
Allis-Chalmers Mfg. Co.
American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
American-Marsh Pumps, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Canton Stoker Corp — "WAGENER"
Carver Pump Co.
Dorr-Oliver Incorporated
The Galigher Co.—"VACSEAL"
Goulds Pumps, Inc.
Goyne Pump Co. (horizontal and vertical)
Guyan Machy. Co.—"GORMAN RUPP"
Linatex Corp. of America
Lincoln Engrg. Co., Div of McNeil Mach. & Engrg. Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Meckum Engineering, Inc.
Morris Machine Works
Nagle Pumps, Inc.
Ore Reclamation Co.
Robbins & Myers, Inc.—"MOYNO"
WEMCO Div., Western Machinery Co.—"WEMCO TORQUE FLOW"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, SLURRY

Morris Machine Works
A. R. Wilfley & Sons

PUMPS, SPRAY HIGH-PRESSURE

Flood City Brass & Electric Co.

PUMPS, SUBMERSIBLE

Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Chicago Pneumatic Tool Co.
The Deming Co.
Flygt Corp.—"FLYGT"
The Gorman-Rupp Co.
Guyan Machy. Co.—"REDA"
Johnston Pump Co., Div. of the Youngstown Sheet and Tube Co.
Kenco Pump Div. of The American Crucible Products Co (3 phase)
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Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett Haentjens & Co
Buffalo Forge Co.—"BUFFALO"
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chicago Pneumatic Tool Co.
The Deming Co.
Emglo Products Corp.—"EMGLO"
Fairbanks Morse & Co.
Flood City Brass & Electric Co.
Flygt Corp.—"FLYGT"
The Galigher Co.—"GALIGHER"
Gardner-Denver Company
M. Glosser & Sons Inc.
The Gorman-Rupp Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Johnston Pump Co., Div. of Youngstown Sheet and Tube Co.
Kenco Pump Div. of The American Crucible Products Co.
Lancaster Pump & Mfg. Co
Layne & Bowler, Inc.—"LAYNE"
Layne & Bowler Pump Co.—"VERTI-LINE"
Le Roi Div., Westinghouse Air Brake Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Morris Machine Works
Nagle Pumps, Inc.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Robbins & Myers, Inc. —"MOYNO"
Schramm, Inc.
Thor Power Tool Co.
Worthington Corp.

PUMPS, TRANSFER

Aro Equipment Corp.
Lincoln Engineering Co., Div. of McNeil Mach. & Engrg. Co.
A. R. Wilfley & Sons

PUMPS, TURBINE

Aurora Pump Div., The New York Air Brake Co.

PUMPS, VACUUM

Allis-Chalmers Mfg. Co.
Canton Stoker Corp.—"WAGENER"
Chicago Pneumatic Tool Co.
Joy Mfg. Co.
Kinney Vacuum Div., The New York Air Brake Co.
Nash Engineering Co.

PUMPS, VERTICAL CENTRIFUGAL

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Barrett, Haentjens & Co.
Buffalo Forge Co.—"BUFFALO"
Dean Brothers Pumps Inc.
The Gorman-Rupp Co.
Lancaster Pump & Mfg. Co., Inc.
Morris Machine Works
Nagle Pumps, Inc.

PUMPS, VERTICAL, CENTRIFUGAL AND TURBINE

Allis-Chalmers Mfg. Co.
American Well Works
Aurora Pump Div., The New York Air Brake Co.
Byron Jackson Pumps, Inc. A Sub. of Borg-Warner Corp.
Carver Pump Co.
The Deming Co.
Ensign Electric & Mfg Co.
Fairbanks Morse & Co.
Goulds Pump, Inc.
Ingersoll-Rand Co.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Pennsylvania Drilling Co.
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, VERTICAL, TURBINE

Johnston Pump Co., Div. of The Youngstown Sheet & Tube Co.
Layne & Bowler, Inc.—"LAYNE"

PUSHBUTTONS

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Cutler-Hammer, Inc.—"ROTO-PUSH"
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

PUSHBUTTONS, OILTIGHT

Cutler-Hammer, Inc.

PYROMETERS

The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division —"ELRONIK"
West Instrument Corp.—"GARDSMAN-VERI-TELL"

RADIO SYSTEMS

General Electric Co., Communication Products Dept.
Mine Safety Appliances Co.—"MINE PHONE"
Motorola Communications & Electronics, Inc —"MOTRAE (Two-way radio)," "T-POWER (Two-way radio)"

RAIL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I," "HI-SI"
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Morse Bros. Machinery Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"
United States Steel Corp

RAIL BENDERS

The Aldon Co.
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE" "RATCHET TYPE"
National Mine Service Co.
Utility Mine Equipment Co.— "UMECO"
Watt Car & Wheel Co.

RAIL BOLTS

Bethlehem Steel Co.
The Colorndo Fuel & Iron Corp. —"C F & I"
Gibraltar Equipment & Mfg. Co.
Morse Bros Machinery Co.
Screw and Bolt Corp. of America

RAIL-BOND TERMINALS

American Mine Door Co.

RAIL BONDS

American Steel & Wire Div., U. S. Steel Corp.—"TIGER-WELD," "TIGER-BRAZE"
Cable Vulcanizing Shop, Inc.
Copperweld Steel Co.—"COPPERWELD"
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Penn Machine Co.—"EVERLAST SUPER-WELD"

RAIL BRACES

Bethlehem Steel Co.
The Nolan Co.
H. K. Porter Co., Connors, Steel Div.—"WEST VIRGINIA"

RAIL CLAMPS

Dravo Corp.
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co.
Mosebach Electric & Supply Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

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General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

RAIL CROSSINGS, RUBBER

Goodyear Tire & Rubber Co.

RAIL DOLLIES

Templeton, Kenly & Co.— "SIMPLEX"

RAIL DRILLS

Gibraltar Equipment & Mfg. Co. —"RICHTAL HEAVY DUTY"

RAIL FROGS

Bethlehem Steel Co.
C. S. Card Iron Works
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAIL LEVELERS, SPOT BOARDS

Gibraltar Equipment & Mfg. Co. —"GEMO TRU-BLU"

RAIL PUNCHES

Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE"
Mine Safety Appliances Co.— "VELOCITY-POWER"
National Mine Service Co.
Utility Mine Equipment Co.— "UMECO"

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New York Central System

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General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

RAIL SPIKE DRIVERS

American Brake Shoe Co., Railroad Products Div.

RAIL SPIKES

Bethlehem Steel Co.
The Colorado Fuel & Iron Corp., "C F & I"
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
The Youngstown Sheet and Tube Co.

RAIL SPIKES, RAILROAD

Jones & Laughlin Steel Corp.

RAIL SPLICE BARS, PLATES

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Morse Bros. Machinery Co.

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RAIL SWITCHTHROWERS

General Equipment & Manufacturing Co.
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RAIL SWITCHTHROWERS, AIR, AUTOMATIC

American Mine Door Co.— "AERO-THROW"

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Cheatham Elec. Switching Device Co.—"CHEATHAM SWITCH"
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Joy Mfg. Co.

RAIL TIE PLATES

Bethlehem Steel Co.
Morse Bros. Machinery Co.
United States Steel Corp.

RAIL-TIE SPACER BARS

A. M. Byers Co.

RAIL & TIE TONGS

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Koppers Co., Inc., Wood Preserving Div. (creosoted)—"WOLMANIZED"

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National Mine Service Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

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American Brake Shoe Co., Railroad Products Div.

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Bethlehem Steel Co.
C. S. Card Iron Works
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RAIL WELDING MATERIALS

American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
Thermex Metallurgical, Inc.

RAILS, GUARD

Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAILS, TRANSITION

C. S. Card Iron Works
Miners Hardware Supply Co.

REGULATORS, DRAFT

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division

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Cutler-Hammer, Inc.

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A. W. Cash Valve Mfg. Corp.
Fischer & Porter Co.
Hauck Mfg. Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
Rockwell Mfg. Co.

REGULATORS, TEMPERATURE

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
Fischer & Porter Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.— "GARDSMAN"

REGULATORS, VOLTAGE

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Perkin Engineering Corp.
Westinghouse Electric Corp.

REGULATORS, WATER LEVEL

Flygt Corp.—"FLYGT"

RELAYS, ELECTRIC

Allis-Chalmers Mfg. Co.
Cheatham Elec. Switching Device Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
General Equipment & Manufacturing Co.
Joy Mfg. Co.
Nachod & U. S. Signal Co.
Westinghouse Electric Corp.

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Union Switch & Signal Div. Westinghouse Air Brake Co.

RELAYS, MERCURY

Durakool, Inc.
Joy Mfg. Co.
Mining Machine Parts Inc.

RELAYS, MINIATURE

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Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co —"GEMCO TRU-BLUE"
Miners Hardware Supply Co.
The Nolan Co.
Sanford Day Iron Works, Inc.

RESINS, IMPREGNATING

Minnesota Mining & Mfg. Co. —"SCOTCHCAST"

RESISTORS

Clark Controller Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"GUYAN"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Keystone Carbon Co.—"NTC"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Carbon Co.—"OHIOHM"
Penn Machine Co.
The Post Glover Electric Co.— "P-G STEEL GRID"
Stackpole Carbon Co.
Westinghouse Electric Corp.

RESPIRATORS

American Optical Co., Safety Products Div.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co—"GS"
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Pulmosan Safety Equip. Co.
United States Rubber Co.

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Link-Belt Co., Dept. CAMGL-60

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Central Scientific Co.
Clark Controller Co.
Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
Hercules Powder Co.
National Powder Co.
Westinghouse Electric Corp.

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Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Link Belt Co., Dept. CAMGL-60
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

RIVETS

Bethlehem Steel Co.
Republic Steel—"REPUBLIC"

RIVETS, BIFURCATED, SELF-CLINCHING

Crescent Belt Fastener Co.— "CRESCENT"

ROCK-DUST DISTRIBUTORS, DRY

American Mine Door Co.— "DUSTMASTER, MIGHTY MIDGET," "LITTLE CHIEF"
Imperial-Cantrell Mfg. Co.— "JET"
Mine Safety Appliances Co.— "BANTAM," "BANTAM 400," "TYPE S"

ROCK-DUST DISTRIBUTORS, WET

American Mine Door Co.— "LITTLE CHIEF"
Central Mine Supply Co. Div. Pickard Industries Inc.—"NO DUST"
Mine Safety Appliances Co.— "BANTAM 400 SLURRY TYPE"

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Kern Instruments, Inc.

ROLLERS, CAST-IRON

Farrell-Cheek Steel Co.
Link-Belt Co., Dept. CAMGL-60
Webster Mfg., Inc.

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Austin-Western, Construction Equipment Div., Baldwin-Lima Hamilton Corp.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"

ROLLERS, SLOPE, CAST IRON, STEEL

C. S. Card Iron Works
Farrell-Cheek Steel Co.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Sanford Day Iron Works, Inc.
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C. S. Card Iron Works
J. V. Hammond Co.

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Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"FURN-A-RAM," "RAM-CAST," "HI RAM"

READOUT INSTRUMENTS, DATA DISPLAY AND TRANSFER

Union Switch & Signal, Div. of Westinghouse Air Brake Co.— "READALL"

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RECORDERS, TEMPERATURE

West Instrument Corp.— "MARKSMAN"

RECTIFIERS, COPPER-OXIDE

Union Switch & Signal, Div. of Westinghouse Air Brake Co.

RECTIFIERS, GERMANIUM

Allis-Chalmers Mfg. Co.

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Perkin Engineering Corp.
Syntron Co.
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RECTIFIERS, SILICON

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I-T-E Circuit Breaker Co.
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Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co. "LUB-REELS"

REFRACTORIES

Bigelow-Liptak Corp.
Philip Carey Mfg. Co.
Corhart Refractories Co., Sub. of Corning Glass Works
Joseph Dixon Crucible Co.
Johns-Manville—"FIRE-CRETE," "BLAZE-CRETE," "HELLITE," "FIREITE"
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.
Norton Co.—"ALUNDUM," "CRYSTOLON," "MAGNO-RIT," "ZIRCONIUM OXIDE"

REFRACTORIES, ABRASION-RESISTANT

Corhart Refractories Co., Sub. of Corning Glass Works—"CORHART ZAC ELECTRO-CAST REFRACTORY"

REFRACTORIES, CASTIBLE

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"FURNAS-CRETE," "HI-STRENGTH F-334S," "I-R-C," "I-R-C 20," "MEXICAST," "MILL-CRETE," "PUROCAST 3000," "PUROTAB," "SAKONITE," "LOERODE," "ACITAB"

REFRACTORIES, CHROME

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"CHROME CONCRETE," "HILO-CHROME," "SUPER CHROME CONCRETE"

REFRACTORIES, GRAPHITE

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"HELSPOT," "HELSKOTE," "STULKOTE"

REFRACTORIES, PLASTIC

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"MAX BOND," "MONO-FIBRIK," "SUPER MONO-FIBRIK T-9"

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ROOF BOLT EXPANSION SHELLS

Bethlehem Steel Co.
National Mine Service Co.
Thompson Products Valve Div., Thompson Ramo Wooldridge Inc.—"TOP-TITE"

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The Colorado Fuel & Iron Corp. —"C F & I"
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H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA" "WEDGEGRIP" "W-HOLE-GRIP"
Republic Steel—"REPUBLIC"
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The Youngstown Sheet and Tube Co.

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Sika Chemical Corp.—"PERFO SYSTEM"

ROOF BOLTS, SQUARE HEAD

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Sheffield Div., Armco Steel Corp.

ROOF BOLTS, SUSPENSION-ARM

H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

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The Youngstown Sheet and Tube Co.

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National Mine Service Co.
Pattin Manufacturing Co.
Republic Steel—"REPUBLIC"

ROOF COATINGS

Master Bronze Powder Co., Inc. —"BROMA TOPS"

ROOF DRAINS

Zurn Industries, Inc., Plumbing Products Div.—"ZURN"

ROOF RESURFACERS

Stonhard Co.—"STONSHIELD"

ROOF SUPPORTS, HYDRAULIC

Mining Progress, Inc.

ROOF SUPPORTS, SELF-ADVANCING

Dowty Mining Equipment Ltd.
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ROOF SUPPORTS, YIELDABLE ARCH

Bethlehem Steel Co.
Herold Mfg. Co.
Mining Progress, Inc.

ROOF SUPPORTS, YIELDING MINE PROPS

Herold Mfg. Co.
Mining Progress, Inc.

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ILG Electric Ventilating Co.— "ILG"

ROOF VENTILATORS, POWER

American-Standard Industrial Div.

ROOFING, FLASHING, COPPER

Revere Copper & Brass Inc.

ROOFING, FLASHING, NICKEL ALLOY

International Nickel Co., Inc.

ROOFING, FLASHING-ZINC

Illinois Zinc Co.

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T. J. Moss Tie Co.
Revere Copper & Brass Inc.
Reynolds Metals Co.
Thomas Engineering & Construction Co.

ROOFING, SIDING, ASBESTOS

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Johns-Manville—"TRANSITE FLEX-STONE" "ADQUA-DAM"
Keasbey & Mattison Co.
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The Ruberoid Co.

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Arrowhead Engineers and Constructors, Inc.
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T. J. Moss Tie Co.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Thomas Engineering & Construction Co.
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Illinois Zinc Co.

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Drills, roof-bolting, rotary impact tools for

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E. D. Bullard Co.—"MORENCI"
Filtration Engineers Div., American Machine & Metals Inc.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

SAFETY DISPLAYS, SIGNS

Elliott Service Co., Inc.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.—"M-S-A"

SAFETY EQUIPMENT

Mine Safety Appliances Co.

SAFETY FOOTGEAR, LEATHER

Filtration Engineers Div., American Machine & Metals Inc.
Hy-Test Safety Shoe Div., International Shoe Co.—"HY-TEST"
Mine Safety Appliances Co.

SAFETY FOOTGEAR, RUBBER

Filtration Engineers Div., American Machine & Metals Inc.
Goodall Rubber Co.
B. F. Goodrich Footwear and Flooring Co.—"FLEXI-PRENE," "FLEXIGLUV," "GRIP-ALL," "KOROSEAL," "ARRASKYN"
Mine Safety Appliances Co.

SAFETY HEADGEAR

American Optical Co., Safety Products Div.
E. D. Bullard Co.—"HARD-BOILED"
Filtration Engineers Div., American Machine & Metals Inc.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.—"SKULL-GARD," "COMFO CAP"
National Mine Service Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"SAFHED"

SAFETY HOOKS

E. D. Bullard Co.—"BULLARD"
Coffing Hoist Div., Duff-Norton Co.
Crosby-Laughlin Div. American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
General Scientific Equipment Co.—"GS"
Shepard Niles Crane & Hoist Corp.

SAFETY SIGNS REFLECTORIZED

Mine Safety Appliances Co.—"SCOTCHLITE BRAND"

SALT

International Salt Co. —"STERLING"
Morton Salt Co.—"MORTON"

SALT, ROCK

International Salt Co. —"STERLING"

SALT, WITH RUST INHIBITOR

Diamond Crystal Salt Co.

SALT TABLETS

E. D. Bullard Co.
Morton Salt Co.—"MORTON"
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"PEP-UP"

SAMPLERS, COAL

Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-60
Moble Drilling, Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sturtevant Mill Co.

SAMPLERS, COAL, AUTOMATIC

Denver Equipment Co.—"DECO"
The Galigher Co.—"GEARY," "JENNINGS"
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Mine and Smelter Supply Co.—"VEZIN"
Sturtevant Mill Co.

SAND DRIERS

Barber-Greene Co.
J. D. Christian Engineers
Cowanesque Valley Iron Works—"SUTTON"
Denver Equipment Co.
The Eimco Corp.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Pioneer Engineering, Div. of Poor & Co.

SANDERS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.

SAW BLADES

Disston Div., H. K. Porter Co., Inc.
Ladish Co.
Martindale Electric Co.
Simonds Saw & Steel Co.—"SI-CLONE"

SAWS, BAND

Simonds Saw & Steel Co.

SAWS, BOW

Gensco Tools Div., General Steel Warehouse Co., Inc.

SAWS, CARBIDE-TIPPED

Simonds Saw and Steel Co.

SAWS, CHAIN

Homelite, a div. of Textron, Inc.
Vulcan Iron Works Co. (Denver)—"PORTOCUT"

SAWS, CIRCULAR

The Black & Decker Mfg. Co.
Martindale Electric Co.
Simonds Saw & Steel Co.—"RED CENTER"

SAWS, HACK

Disston Div., H. K. Porter Co., Inc.
Simonds Saw & Steel Co.
Snap-on Tools Corp.

SAWS, HAND

Disston Div., H. K. Porter Co., Inc.
Gensco Tools Div., General Steel Warehouse Co., Inc.

SAWS, METAL CUTTING

Simonds Saw and Steel Co.

SAWS, MINE & UTILITY

Disston Div., H. K. Porter Co., Inc.

SAWS, PORTABLE AIR

Herold Mfg. Co.
Remington Arms Co., Inc.

SAWS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Remington Arms Co., Inc.
Syntron Co.
Thor Power Tool Co.

SAWS, PORTABLE GASOLINE

Lancaster Pumps & Mfg. Co., Inc.
Remington Arms Co., Inc.

SAWS, POWER

Thor Power Tool Co.

SAWS, POWER, AIR

Ingersoll-Rand Co.

SAWS, RECIPROCATING BLADE, AIR, GASOLINE

Wright Power Saw & Tool Corp., Div. of Thomas Industries Inc.

SCALE-WEIGHT RECORDERS

Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Howe Scale Co., Inc.—"MECHANOPRINT"
Industrial Physics & Electronics Co.
Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCALE-WEIGHT RECORDERS, CONVEYOR

Merrick Scale Mfg. Co.—"WEIGHTOMETER"

SCALES—See also CONVEYOR WEIGHERS

SCALES, AXLE-LOAD

Winslow Government Standard Scale Works, Inc.

SCALES, LOAD-CELL

Howe Scale Co.—"HOWE-TRONIC"

SCALES, MINE-CAR TRUCK

Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Howe Scale Co., Inc.
Morse Bros. Machinery Co.
Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCALES, PORTABLE

Howe Scale Co.

SCALES, PORTABLE TRUCK

Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCALES, R. R.

Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Morse Bros. Machinery Co.
Winslow Government Standard Scale Works, Inc.

SCALES, R.R. TRACK

Howe Scale Co.

SCALES, TRUCK

Thurman Scale Co., Div. Thurman Mfg. Co.

SCALES, WEIGHING

Howe Scale Co.—"WEIGHTOGRAPH"
Manning, Maxwell & Moore Inc., Shaw-Box Crane & Hoist Div.—"MMM"
Thurman Scale Co., Div. Thurman Mfg. Co.

SCRAPER TIPS, TEETH

American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"

SCRAPERS, DISC-FILTER

Peterson Filters & Engineering Co.—"DUAL GUIDE," "CONTOUR"

SCRAPERS, DRAG

Jeffrey Mfg. Co.
Joy Mfg. Co.
Laubenstein Mfg. Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sauerman Bros., Inc.—"CRESCENT"
Thomas Engineering & Construction Co.

SCRAPERS, SELF-POWERED

Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Euclid Div., General Motors Corp.
International Harvester Co.—"PAYSCRAPER"
Joy Mfg. Co.
R. G. LeTourneau, Inc.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
South Bend Div., Curtiss-Wright Corp.

SCRAPERS, SHOT-HOLE

The Leetonia Tool Co.

SCRAPERS, TRACTOR-DRAWN

Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
International Harvester Co.
LeTourneau-Westinghouse Co.
The Oliver Corp.—"OLIVER"
South Bend Div., Curtiss Wright Corp.

SCRAPERS, UNDERGROUND

The Eimco Corp.
Joy Mfg. Co.
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

SCREEN BARS

The Colorado Fuel & Iron Corp.—"C F & I"
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-60
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Salem-Brosius, Inc.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.
Wedge Wire Corp.—"KLEEN-SLOT"

SCREEN CLOTH & WIRE

Cleveland Wire Cloth & Mfg. Co.
The Colorado Fuel & Iron Corp.—"C F & I"
Cross Perforated Metals Plant, National-Standard Co.—"RIMA"
Diamond Iron Works, Div. Goodman Mfg. Co.
John Flocker & Co.
Hewitt-Robins Incorporated—"GYRALOY," "SUPER GYRALOY"
Hoyt Wire Cloth Co.—"SUPERTOUGH," "ABRASO," "SUPERHARD STAINLESS STEEL," "SMOOTHTOP," "LONGSLOT," "OBLONG," "DOUBLE CRIMP"
Iowa Mfg. Co.
Ludlow Saylor Wire Cloth Co.—"ARCHCRIMP," "STA-SMOOTH," "STA-CLEAN," "STA-TRU," "REKTANG," "LUDLOW," "SUPER-LOY, PERFECT"
Newark Wire Cloth Co.
Simplicity Engineering Co.
W. S. Tyler Co.—"DOUBLE-CRIMP," "TON-CAP," "TY-ROD," "CORDUROY"

SCREEN-CLOTH HEATERS

The Deister Concentrator Co., Inc.—"FLEXELEX"
F. R. Hannon & Sons—"HANCO"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60
Productive Equipment Corp.
Screen Equipment Co., Inc.—"HANNON"
Simplicity Engineering Co.
W. S. Tyler Co.—"TY-ELECTRIC"

SCREEN MESH CLOTH

Cleveland Wire Cloth & Mfg. Co.
Hewitt-Robins Incorporated.

SCREEN PLATE, PERFORATED

Chicago Perforating Co.
Cross Perforated Metals Plant, National-Standard Co.—"CROSS," "CONIDURE," "HEXSCREEN," "CONIDURE," centrifugal
The Harrington & King Perforating Co., Inc.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Sensenich Corp.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Remaly Mfg. Co. Inc.
Salem-Brosius, Inc.
W. J. Savage Co.
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.

SCREEN SECTIONS, VIBRATOR REPLACEMENT

Cleveland Wire Cloth & Mfg. Co.
Hewitt-Robins Incorporated
Hoyt Wire Cloth Co.
Link-Belt Co., Dept. CAMGL-60

SCREEN SECTIONS, VIBRATOR, ELECTRICALLY HEATED

Cleveland Wire Cloth & Mfg. Co.
Link-Belt Co., Dept. CAMGL-60

SCREENS

Carrier Conveyor, div. Chain Belt Co.—"CARRIER NATURAL FREQUENCY"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60

SCREENS, CENTRIFUGAL

Bird Machine Co.—"BIRD-HUMBOLDT"
Centrifugal & Mech. Industries, Inc.—"C-M-I"
Hendrick Mfg. Co.
Heyl & Patterson, Inc.—"RE-INEVELD"
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Newark Wire Cloth Co.
Nordberg Mfg. Co.—"SYMONS"
W. S. Tyler Co.

SCREENS, DEWATERING

Allis-Chalmers Mfg. Co.
Bird Machine Co.
Denver Equipment Co.—"DEN-VER"
Fairmont Machinery Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated—"FLIPTEX DE-WATERIZER"
Hoyt Wire Cloth Co.
Jeffrey Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.—"MECKUM-SKB"
Newark Wire Cloth Co.
The Nolan Co.
Nordberg Mfg. Co.—"SYMONS"
Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Screen Equipment Co. Inc.—"SECO"
Simplicity Engineering Co.
Smith Engineering Works—"TELSMITH"
W. S. Tyler Co.
Wedge Wire Corp.—"KLEEN-SLOT"

SCREENS, DRIER

Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-60

SCREENS, INCLINED STATIONARY

Heyl & Patterson, Inc.—"H & P SIEVE BEND"
Link-Belt Co., Dept. CAMGL-60

SCREENS, REVOLVING

Allis-Chalmers Mfg. Co.
Denver Equipment Co.—"DEN-VER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Hendrick Mfg. Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Lippmann Engrg. Works Inc.
McLanahan & Stone Corp.
Nordberg Mfg. Co.—"SYMONS V-SCREEN"
Pioneer Engineering, Div. of Poor & Co.
W. J. Savage Co.
Smith Engineering Works—"TELSMITH"
W. S. Tyler Co.
Universal Road Machinery Co.—"RELIANCE"
Webster Mfg., Inc.

SCREENS, ROD

Allis-Chalmers Mfg. Co.
Bixby-Zimmer Engineering Co.
Link-Belt Co., Dept. CAMGL-60
Nordberg Mfg. Co.—"SYMONS"
W. S. Tyler Co.—"TY-LOC"

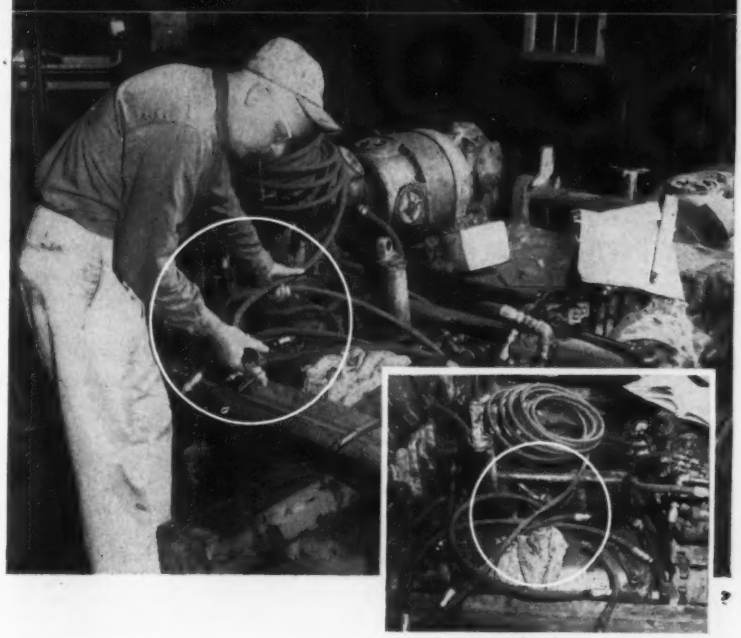
SCREENS, SHAKER

Central Scientific Co.
The Colorado Fuel & Iron Corp.—"CF&I," "SUPER-TEMPERED," "WISSCOLOY"
Fairmont Machinery Co.
Fisher Scientific Co.

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W. J. Savage Co.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.

SCREENS, SHAKER, REPLACEMENT SECTIONS

Cleveland Wire Cloth & Mfg. Co.
Link-Belt Co., Dept. CAMGL-60

SCREENS, TESTING

Commercial Testing & Engineering Co.

SCREENS, VIBRATING

Allis-Chalmers Mfg. Co.
The Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.—"CF&I," "SUPER-TEMPERED," "WISSCOLOY"
The Deister Concentrator Co., Inc.—"LEAHY HEAVY DUTY NO BLIND"
Deister Machine Co.
Denver Equipment Co.—"DENVER-DILLON"
Diamond Iron Works, Div. Goodman Mfg. Co.
Dravo Corp.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated—"HI-G," "VIBREX," "ELIP-TEX," "GYREX," "HI-SPEED" "HYDREX"
Hoyt Wire Cloth Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Lecco Machinery & Engineering Co.—"LECCO-VIB"
Link-Belt Co., Dept. CAMGL-60—"BA," "CA," "UP," "CL," "VC," "NRM," "CB," "CM," "SYNCHROMATIC"
Lippmann Engrg. Works Inc.
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Newark Wire Cloth Co.
Nordberg Mfg. Co.—"SYMONS"
NoVo Div., Industrial Enterprises Inc.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.—"SUPER SERVICE MESABI"
Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Remaly Mfg. Co. Inc.
Screen Equipment Co., Inc.—"SECO"
Simplicity Engineering Co.—"SIMPLI-FLO"
Smith Engineering Works—"TELSMITH"
Stedman Foundry & Machine Co., Inc.
Stedman-Adamson Mfg. Co.
Sturtevant Mill Co.
Syntron Co.
W. S. Tyler Co.—"HUMMER" "TY-ROCK," "TYLER-NIAGARA," "TYROCKET"
Universal Vibrating Screen Co. "UNIVERSAL," "UNILEC," "UNIFLEX"
Williams Patent Crusher & Pulv. Co.

SCREENS, VIBRATING, TESTING

Allis-Chalmers Mfg. Co.
Denver Equipment Co.—"DENVER-DILLON"
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60
Newark Wire Cloth Co.
Productive Equipment Corp.
Syntron Co.
W. S. Tyler Co.—"RO-TAP," "TY-LAB"
Universal Vibrating Screen Co.—"UNIVIBE"

SCREENS, WEDGE-WIRE

Allis-Chalmers Mfg. Co.
Bixby-Zimmer Engineering Co.
Cross Perforated Metals Plant, National Standard Co.—"RIMA"
Hendrick Mfg. Co.—"WEDGE-SLOT"
Wedge Wire Corp.—"KLEEN-SLOT"

SCREENS, WOVEN WIRE

W. S. Tyler Co.

SCREW WASHERS

Link-Belt Co., Dept. CAMGL-60

SCREWS, SET

The Leetonia Tool Co.

SCRUBBERS, AIR

The Ducon Co., Inc.
The Johnson-March Corp.—"TYPE A HYDRO-PRECIPITATOR"

SEALANTS

Sika Chemical Corp.—"SIKA EPOXY JOINT SEALER," "SIKA EPOXY CRACK SEALER," "IGAS," "SIKA QUICKSETS"

SEALS, BEARING, GREASE & OIL

Bearings, Inc.
Federal-Mogul Service, Div. of Federal-Mogul Bower Bearings, Inc.—"NATIONAL"
Garlock Inc.—"KLOZURES"
Johns-Manville—"CLIPPER"
United States Rubber Co.
West Virginia Armature Co.

SEALS, SHAFT, MECHANICAL

Anchor Packing Co.
Bearings, Inc.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Garlock Inc.—"MECHANIPAK"
Koppers Co., Inc., Metal Products Div.
Syntron Co.
United States Rubber Co.

SECTIONAL, CONVEYORS

Hewitt-Robins Incorporated

SECTIONALIZING APPARATUS, STRIPPING

Atkinson Armature Works

SEISMOGRAPHS, BLASTING

Vibration Measurement Engineers, Inc.—"SEISMOLOG"

SELF-RESCUERS

Mine Safety Appliances Co.

SEPARATORS, AIR

Hardinge Co., Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company Inc.
Sturtevant Mill Co.
Universal Road Machinery Co.—"RELIANCE—GAYCO"
Williams Patent Crusher & Pulv. Co.

SEPARATORS, HEAVY-MEDIA

Link-Belt Co., Dept. CAMGL-60
WEMCO Div., Western Machinery Co.—"WEMCO CONE," "WEMCO DRUM"

SEPARATORS, METAL, MAGNETIC AND MAGNETIC CONVEYOR

Infilco Inc., Gale Separator Div.—"MAGNEFLEX," "FLEXI-FLIGHT"

SEPARATORS, TROUGH

Link-Belt Co., Dept. CAMGL-60

SEPARATORS, VIBRATING SCREEN

Link-Belt Co., Dept. CAMGL-60
Southwestern Engineering Co.—"SWECO"

SERVICE TRUCKS, SELF PROPELLED

Schroeder Brothers Corp.

SHAFT HANGERS

J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Webster Mfg., Inc.

SHAFT MOTION INDICATOR

The Bin-Dicator Co.—"ROTO-GUARD"

SHAFT RIGS, PNEUMATIC

Schroeder Brothers Corp.

SHAFT-SINKING MACHINES

Shaft and Development Machine Co.—"CRYDERMAN MUCKER"

SHAFT & TUNNEL SUPPORTS

Commercial Shearing & Stamping Co. (Steel plates, ribs, sets & lagging)

SHAFTING, STEEL

Bethlehem Steel Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Transall Inc.
Bertrand P. Tracy Co.

SHAFTS, SPLINED

North American Gear Co.—"NAMCO"

SHAPERS

South Bend Lathe, Inc.

SHAPES, STRUCTURAL, ALUMINUM

Aluminum Company of America
Reynolds Metals Co.

SHEARS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.

SHEAVES

Bethlehem Steel Co.

SHEAVES, BICYCLE-TYPE

Connellsville Mfg. & Mine Supply Co.

SHEAVES, FABRICATED

Connellsville Mfg. & Mine Supply Co.

SHEAVES, HOISTING

American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Vulcan Iron Works, Inc.—"ALL-CASTEEL"
Vulcan Iron Works Co. (Denver)
Wilmot Engineering Co.

SHEAVES, TRACK

C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
Vulcan Iron Works Co. (Denver)

SHEAVES, V-BELT

The American Pulley Co.—"Q-D-V," "3-5-8"
Bethlehem Steel Co.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Co.—"BOSTON"
Browning Mfg. Co.
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Dayton Industrial Products Co.—"DAYTON"
Dodge Mfg. Corp.—"TAPER LOCK," "DYNA-V"
Flood City Brass & Electric Co.
The Gates Rubber Co.
Guyan Machy. Co.
Hewitt-Robins Incorporated—"JONES"
Illinois Gear & Machine Co.
Iowa Mfg. Co.
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
National Mine Service Co.
Ore Reclamation Co.
Pittsburgh Gear Co.
Transall, Inc.
T. B. Woods Sons Co.—"SURE-GRIP" "ULTRA-V"
Worthington Corp.

SHEAVES, WIRE-ROPE

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
C. S. Card Iron Works
Farrell-Cheek Steel Co.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DURO-LITE"
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Vulcan Iron Works, Inc.—"ALL-CASTEEL"
Vulcan Iron Works Co. (Denver)
T. V. Woods Sons Co.

SHEET, CORRUGATED ALUMINUM

Aluminum Co. of America

SHELVING RACKS, ETC.

The Frick-Gallagher Mfg. Co.—"CLIP-BILT"
National Mine Service Co.
Miners' Hardware Supply Co.—"LYONS METAL PRODUCTS"

SHIM STOCK, SHIMS

Crucible Steel Co. of America
B. F. Goodrich Industrial Products Co.

SHOCK ABSORBERS, MACHINE & MOTOR MOUNTS

Continental Rubber Works
United States Rubber Co.

SHOTFIRERS

Femco, Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

SHOVELS, HAND

Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
The Salem Tool Co.—"RED DEVIL"
The Wood Shovel & Tool Co.

SHOVELS, STANDARD POWER-TYPE, COAL LOADING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus-Erie Co.
Gar Wood Industries, Inc.
Harnischfeger Corp
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Orton Crane & Shovel Co.
"Quick-Way" Truck Shovel Co.
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

SHOVELS, STRIPPING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus Erie Co.
Harnischfeger Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
"Quick-Way" Truck Shovel Co.
The Thew Shovel Co.—"LORAIN"

SHOVELS, TRACTOR

Allis Chalmers Mfg. Co.

SHOVELS, TRACTOR MOUNTED

The Eimco Corp.

SHOWER-ROOM EQUIPMENT

Onox, Inc.—"ONOX FOOTMATS, ONOX SKIN-TOUGHENER"
Zurn Industries, Inc., Plumbing Products Div.—"ZURN"

SHUTTLE TRAINS, GANGWAY DEVELOPMENT, ELECTRIC, AIR

Herold Mfg. Co.

SIEVES, TESTING
Central Scientific Co.
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American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

SIGNALS, HIGHWAY CROSSING
American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.
Union Switch Signal Div., Westinghouse Air Brake Co.

SIGNALS, LIGHT CASES
American Mine Door Co.
General Equipment & Manufacturing Co.
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SILOS, ASH, COAL & SAND STORAGE
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Marietta Concrete Div., American-Marietta Co.
The Neff & Fry Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

SKIDS, MINE-CAR
Bethlehem Steel Co.
Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Irwin Sensenich Corp.
Miners Hardware Supply Co.
Sanford Day Iron Works, Inc.

SKIN CREAMS, PROTECTIVE
American Optical Co., Safety Products Div.—"SAFETI-COTE"

SKIP WHEELS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

SKIPS, AUTOMATIC LOADING EQUIPMENT
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-60

SKIPS, MINE-HOISTING
Connellsville Mfg. & Mine Supply Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Mayo Tunnel & Mine Equipment Co.
The Stearns-Roger Mfg. Co.
Vulcan Iron Works, Inc.
Vulcan Iron Works Co. (Denver)
Webster Mfg., Inc.

SKIRTBOARDS, RUBBER
Paltech Co.

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C. R. Daniels Co.
B. F. Goodrich Co., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.

SLINGS, CHAIN
American Chain Div., American Chain & Cable Co., Inc.
Columbus McKinnon Chain Corp., Mining Equipment Div.
John Flocker & Co.
Manning, Maxwell & Moore, Inc. Shaw-Box Crane & Hoist Div.—"TIPIT"
Joseph T. Ryerson & Son, Inc.

SLINGS, WIRE-ROPE
American Chain & Cable—"ACCO REGISTERED," "DUALOC"
Bergen Wire Rope Co.
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND," "B & B," "BROLOC," "THRIF-T-LIFT"
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Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.



Write for details on the new Thermit Self-Preheat Weld.

Only 5 minutes
to make a RAIL WELD!

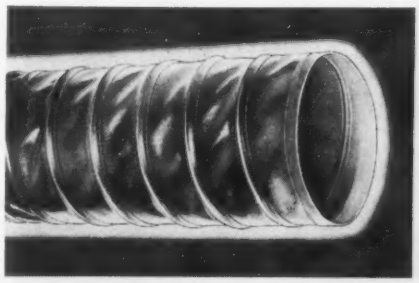
Because only three simple steps are required: 1. aligning the rails, 2. applying the molds and 3. pouring in and igniting the welding compound, modern Thermit Welding is the easiest and speediest of all rail welding methods. Time-consuming preheating of rail ends is no longer necessary. The use of factory-made molds eliminates ramming of molds on the job. From start to finish you can actually complete a good, sound weld, having 100% electrical conductivity, in just five minutes.

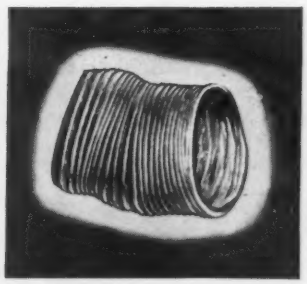
Cost compares favorably with installing mechanical rail joints. Old rail as well as new can be welded. And, rail can be welded in track.

THERMIT Rail WELDING

Thermex Metallurgical, Inc., Lakehurst, New Jersey

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For efficient, economical removal by suction of fouled air and dust from the working face of mines. Can also be used for blowing in fresh air. Sturdy fabrics used are neoprene coated both sides to resist friction and are airtight. *Withstands flexing and retracting.* Easy to hang on carrier wire. Simple to couple. Yellow for visibility. Send for Bulletin 360.

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  Resistant to scuffing, acids, oils, moisture, atmosphere. Wire is totally enclosed. No spiral stitches to wear out.
- **LIGHTWEIGHT**
  ⅓ the weight of metal duct of comparable diameter. One man can erect Mine Duct.
- **FLAME RESISTANT**
  Resistant to combustion — will not support flame.
- **RETRACTABLE**
  Can be compressed into small space for carrying or storage.

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Union Wire Rope Corp. Sub. of Armco Steel Corp.—"TUFFY"
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Wire Rope Corp. of America, Inc.—"WIRECO"

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Farrel-Birmingham Co., Inc.

SLUDGE RECOVERY SYSTEMS

Link-Belt Co. Dept. CAMGL-60

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Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

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General Electric Co., Apparatus Sales Div.
General Equipment & Manufacturing Co.

SOLENOIDS, D.C. HEAVY DUTY

Cheatham Electric Switching Device Co.

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Cities Service Oil Co.
Columbia-Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Esso Standard Div. of Humble Oil and Refining Co.—"VARSOL," "ESSO VARSOL"
Fisher Scientific Co.
Martindale Electric Co.
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sun Oil Co.—"SUN SPIRITS"
Wyandotte Chemicals Corp.

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American Mine Supply Co.

SPAD HANGERS

American Mine Supply Co.

SPADS

American Mine Supply Co.
Black Diamond Spad Co.—"BLACK DIAMOND"
Howells Mining Drill Co.—"HOWELLS"

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Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"STYL-IZE"

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J. D. Christian Engineers
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co., Dept. CAMGL-60
U.S. Electrical Motors, Inc.—"SYNCRO GEAR"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS

The American Pulley Co.—"SHAFT-KING," "SCREW-KING"
J. D. Christian Engineers—"RITE-LO-SPEED"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"TORQUE-ARM"
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Corp.—"HYGRADE," "LINE-O-POWER," "MAXI-POWER," "LINE-O-MOUNT" "SHAFT-MOUNT"
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT," "IN-LINE HELICAL," "PARALLEL SHAFT," "GEAR-MOTOR," "P. I. V.," "MOTOGEAR," "UNIVERSAL"
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The Master Electric Co., Div. of Reliance Electric & Engr. Co.
Mining Progress, Inc.
Morse Chain Co. A Borg-Warner Industry—"EBERHARDT DENVER," "NITER BOX," "'C' FLANGE GERMOTOR," "POWER GEAR"
Ore Reclamation Co.
Reliance Electric and Eng. Co.
Stephens-Adamson Mfg. Co.—"SACO"
Sterling Electric Motors, Inc.—"STERLING MULTI-MOUNT"
Transall, Inc.
U. S. Electrical Motors, Inc.—"SYNCROGEAR"
Tulsa Winch Div. of Vickers, Inc.—"TULSA"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS, WORM

Link-Belt Co., Dept. CAMGL-60—"UNIVERSAL," "FAN-COOLED"

SPEED, REDUCERS, WORM GEAR

Cleveland Worm & Gear Div., Eaton Mfg. Co.—"CLEVELAND," "SPEEDAIRE"
Cone-Drive Gears Div., Michigan Tool Co.
Link-Belt Co., Dept CAMGL-60—"UNIVERSAL," "FAN-COOLED"

SPIKE PULLERS

Gibraltar Equipment & Mfg. Co.

SPIKES, TRACK—See Rail Spikes

SPIRALS, COAL

Mining Progress, Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"

SPLICING COMPOUNDS, MATERIALS—SEE Conveyor Belting Splicing Materials

SPRAY COMPOUNDS

Fuel Process Co. (Inc.)
The Johnson-March Corp.—"COMPOUND MR"

SPRAY OILS

Ashland Oil & Refining Co.—"ASHLAND PERMATREAT"
Cities Service Oil Co.
Esso Standard, Div. of Humble Oil and Refining Co.—"KOLAY"
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Standard Oil Co. (Ind.)
Sun Oil Co.—"COAL KOTE"
Texaco Inc.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.

SPRAYERS, HIGH-PRESSURE

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

SPRAYING EQUIPMENT—SEE also Dustproofing Equipment

SPRAYING EQUIPMENT, OIL

Keenan Oil Co.
Megator Corp.—"MEGATOR-CONFLOW"
Sanford Day Iron Works, Inc.
W. J. Savage Co.—"RACINE"

SPRAY EQUIPMENT, PAINT

Gray Co., Inc.

SPRAYING EQUIPMENT, WATER & COMPOUNDS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROSPRAY® 52 BINDER"
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
The Johnson-March Corp.
Megator Corp.—"MEGATOR-CONFLOW"

SPRING PINS, SELF-LOCKING

Elastic Stop Nut Corp. of America—"ROLLPIN"

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American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
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Guyan Machy. Co.
Helmick Foundry-Machine Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-60—"LINK-BELT," "FLINT RIM," "DOUBLE DUTY," "TAPER LOCK"
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McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.—"MANGALOY"
National Mine Sservice Co.
North American Gear Co.—"NAMCO"
Ore Reclamation Co.
Penn Machine Co.
W. J. Savage Co.
Taylor-Wharton Co. Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall, Inc.
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
Wilmot Engineering Co.

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Link-Belt Co., Dept. CAMGL-60
Webster Mfg., Inc.

SPROCKETS, COAL CUTTERS

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Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Frank Prox Company, Inc.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.

SPROCKETS, CUT-TOOTH

Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-60

SPROCKETS, ROLLER CHAIN

Dodge Mfg. Corp.
Flood City Brass & Electric Co.
Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-60—"RC," "FR"
Morse Chain Co., A Borg-Warner Industry

SPROCKETS, SILENT CHAIN

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SPROCKETS, TAPER-BORE

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SPROCKETS, TIMING-BELT

Morse Chain Co., A Borg-Warner Industry

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STACKERS, RECLAIMERS, COAL

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Dravo Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60
Pioneer Engineering Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

STAIR TREADS

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Dravo Corp.
General Scientific Equipment Co.—"GS"
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Joseph T. Ryerson & Son, Inc.

STARTERS—SEE Motor Controllers, Starters

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Aluminum Co. of America—"UNITRACE"

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Mayo Tunnel & Mine Equipment

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American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
A. M. Byers Co.—"BYLOY W-2"
Crucible Steel Co. of America
Electric Steel Foundry Co.
Inland Steel Co. (medium & high hardness)
Jones & Laughlin Steel Corp.—"JALLOY"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Taylor-Wharton Co., Div., Harsco Corp.
United States Steel Corp.—"USS A-R"
The Youngstown Sheet and Tube Co.

STEEL, ALLOY

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
The Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.—"JALLOY"
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS," "T-1"
Republic Steel—"REPUBLIC"
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Stulz-Sickles Co.—"MANGANAL"
The Timken Roller Bearing Co.
United States Steel Corp.—"USS CARILLOY," "USS T-1," "USS FC," "USS SUPERKORE"
The Youngstown Sheet and Tube Co.

STEEL, ALLOY FREE MACHINING

Bethlehem Steel Co.
Crucible Steel Co. of America

STEEL, CARBON

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Bethlehem Steel Co.
Crucible Steel Co. of America
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Inland Steel Co.—"TI-NAMEL"
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS"
Phoenix Steel Corp., Structural & Tube Divs.
Republic Steel—"REPUBLIC"
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Sheffield Div., Armco Steel Corp.
United States Steel Corp.
The Youngstown Sheet and Tube Co.

STEEL, CAST CORROSION-RESISTANT

Electro-Alloys Div., American Brake Shoe Co.

STEEL, CAST HEAT-RESISTANT ALLOY

Electro-Alloys Div. American Brake Shoe Co.

STEEL, CLAD

Lukens Steel Co.—"LUKENS"

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Bethlehem Steel Co.
Crucible Steel Co. of America
Electro-Alloys Div. American Brake Shoe Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
The Youngstown Sheet and Tube Co.

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A. M. Byers Co.

STEEL, GALVANIZED

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Inland Steel Co.—"TM-TI-CO," "PAINT-TITE"

STEEL, HEAT RESISTANT ALLOY

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Electro-Alloys Div., American Brake Shoe Co.

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Bethlehem Steel Co.
The Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Inland Steel Co.—"TM-HI-STEEL," "HI-MAN," "TRI-STEEL," "HI-MAN 440"
Jones & Laughlin Steel Corp.—"JALTEN"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
Stulz-Sickles Co.—"MAN-GANAL"
United States Steel Corp.—"USS CORTEN," "USS MAN-TEN," "USS TRI-TEN"

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The Youngstown Sheet and Tube Co.

STEEL, NICKEL

Lukens Steel Co.—"LUKENS LINE"

STEEL, REINFORCING

Bethlehem Steel Co.

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H. K. Porter Co., Connors Steel Div.—"CONNORS"

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American Steel & Wire Div., U.S. Steel Corp.
The Colorado Fuel & Iron Corp.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC ENDURO"
Joseph T. Ryerson & Son, Inc.
The Timken Roller Bearing Co.
United States Steel Corp.

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The Colorado Fuel Iron Corp.—"C F & I"
Bethlehem Steel Co.
Dravo Corp.
Inland Steel Co.
Jones & Laughlin Steel Corp.—"JUNIOR BEAMS," "JUNIOR TEES," "JUNIOR CHANNELS"
Kanawha Mfg. Co.
Phoenix Steel Corp., Structural & Tube Divs.
H. K. Porter Co., Connors Steel Div.—"CONNORS"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
United States Steel Corp.

STEEL, TOOL

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Bethlehem Steel Co.
Crucible Steel Co. of America—"REX"
Jones & Laughlin Steel Corp.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
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STOKERS

Axeman-Anderson Co.—"ANTHRATUBE"

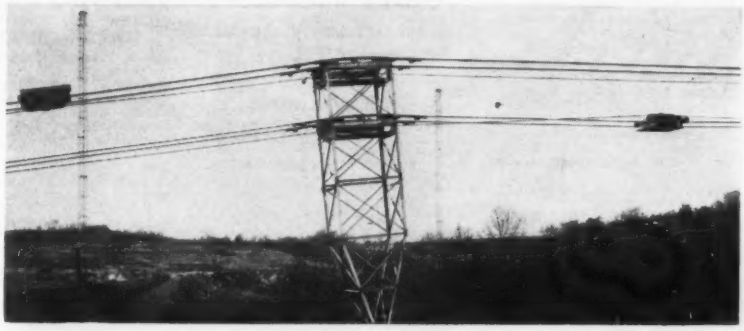
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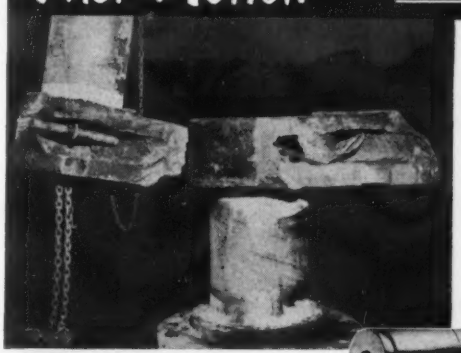
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Auburn Foundry, Inc., Heating Div.—"AUBURN"
Canton Stoker Corp.—"CANTON"
Carpenter Heating & Air Conditioning Co.—"CARPENTER"
Combustion Engineering, Inc.—"C-E"
Dayton Automatic Stoker Co.

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STOPERS, ROOF-BOLTING

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Gardner-Denver Company
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Le Roi Div., Westinghouse Air Brake Co.—"VAC-NUMATIC"
Schroeder Brothers Corp.
Thor Power Tool Co.

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STORAGE PILE PROTECTIVE COATING

The Johnson-March Corp.—"COMPOUND SP"

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Hewitt-Robins Incorporated

STORAGE SYSTEMS, COAL

Link-Belt Co., Dept. CAMGL-60

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Cowanesque Valley Iron Work

STOVES, SAND DRYING

Cowanesque Valley Iron Work

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STOWING MACHINES, PNEUMATIC

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Goyne Pump Co.
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Megator Corp. (floating suction)—"DO' PHIN"
Zurn Industries, Inc., Plumbing Products Div.—"ZURN"

STRAINERS, WATER OIL

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Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD," "ALLUMOWELD"

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Delta-Star Electric Div., H. K. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
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SUBSTATIONS, UNIT

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Geo-Optic & Paper Corp.
Gurley, W. & L. E.
Wild Heerbrugg Instruments, Inc.

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SWEATBANDS

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Flexo Products Inc.—"SPONGE-AIRE"
Pulmosan Safety Equip. Co.

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J. H. Fletcher & Co.

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General Electric Co., Apparatus Sales Div.
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The Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Mosebach Electric & Supply Co.
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SWITCHES, AUTOMATIC

The Nolan Co.

SWITCHES, BELT CONTROL

General Equipment & Manufacturing Co.
Schroeder Brothers Corp.

SWITCHES, CENTRIFUGAL

Ensign Electric & Mfg. Co.

SWITCHES, CONTROL, MOTORMAN OPERATED

Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

SWITCHES, CONVEYOR-BELT STOP

Cheatham Electric Switching Device Co.

SWITCHES, CONVEYOR-CONTROL

General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRIC HAND

Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

SWITCHES, ELECTRICAL

Arrow Hart & Hegeman Electric Co.
Circuit Protective Devices Dept., General Electric Co.
Clark Controller Co.
Cutler-Hammer, Inc.—"C-H"
Delta-Star Electric Div., H. K. Porter Co., Inc.
The Elreco Corp.—"POWER"
G & W Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Ohio Brass Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRICAL, SAFETY

Arrow Hart & Hegeman Electric Co.
Circuit Protective Devices Dept., General Electric Co.
Cutler-Hammer, Inc.—"C-H"
Dooley Brothers
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Westinghouse Electric Corp.

SWITCHES, H.V., INDOOR & OUTDOOR, METAL-ENCLOSED

Delta-Star Electric Div., H. K. Porter Co., Inc.

SWITCHES, LIMIT

General Equipment & Manufacturering Co.
Shepard Niles Crane & Hoist Corp.

SWITCHES, LOCOMOTIVE TRANSFER

Circuit Protective Devices Dept., General Electric Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
The Post Glove Electric Co.—"P-G"

SWITCHES, MERCURY

Durakool, Inc.
Joy Mfg. Co.
The Post Glover Electric Co.—"P-G"

SWITCHES, PRESSURE

Barksdale Valves—"BARKSDALE-MELETRON"

SWITCHES, ROPE-PULL MOMENTARY

American Mine Door Co.
Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.

SWITCHES, THERMOCOUPLE

West Instrument Corp.

SWITCHTHROWERS

See Rail Switchthrowers

TABLE DECKS, WASHING

Linatex Corp. of America

TABLES, AIR-CLEANING

Fairmont Machinery Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.—"SUPER-AIRFLOW"

TABLES, COAL-WASHING

The Daniels Co.
The Deister Concentrator Co., Inc.—"SUPER DUTY NO. 7 DIAGONAL DECK" "CONCENCO '77' DIAGONAL DECK"
Deister Machine Co.
Link-Belt Co., Dept. CAMGL-60
Mine and Smelter Supply Co.—"WILFLEY"

TABLES, DRAFTING

Charles Bruning Co. Inc.

TACHOMETERS

The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Ideal Industries, Inc.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Stewart-Warner Corp., Alemite Div.
Westinghouse Electric Corp.

TAKEOFFS, POWER

Gar Wood Industries, Inc.
Schroeder Brothers Corp.
Twin Disc Clutch Co.
Tulsa Winch Div. of Vickers, Inc.—"TULSA"

TAKEOFFS, POWER, SPLIT SHAFT TYPE

Hendrickson Mfg. Co.

TAKEUPS, BALL, ROLLER

Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-60

TAKEUPS, CONVEYOR

Barber-Greene Co.
Bearings, Inc.
Chain Belt Co., Shafer Bearing Div.—"SHAFER SELF-ALIGNING"
J. D. Christian Engineers
Goodman Mfg. Co.
Hewitt-Robins, Incorporated
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

TAKEUP UNITS, BALL-BEARING

Link-Belt Co., Dept. CAMGL-60

TAKEUP UNITS, SPHERICAL ROLLER BEARING

Link-Belt Co., Dept. CAMGL-60

TAMPERS, MINE TRACK

J. H. Fletcher & Co.

TAMPERS, PNEUMATIC

Chicago Pneumatic Tool Co.
Schroeder Brothers Corp.

TAMPERS, SHOTHOLE

The Leetonia Tool Co.

TAMPING BAGS—See Bags, Tamping

TAMPING PLUGS

National Mine Service Co.

TAMPING POLES, HEADS

The Salem Tool Co.—"McCARTHY"

TAMPING STICKS, WOOD

Duquesne Mine Supply Co.
J. V. Hammond Co.
National Mine Service Co.
National Powder Co.
The Salem Tool Co.—"BLACK DIAMOND"

TANK-LEVEL CONTROLS

Industrial Nucleonics Corp.—"ACCURAY"

TANKS, CLARIFYING, SLUDGE RECOVERY

Bethlehem Steel Co.
Fairmont Machinery Co.
Denver Equipment Co.—"DENVER"
Eagle Iron Works
Link-Belt Co., Dept. CAMGL-60
Peterson Filters & Engineering Co.
K. Prins & Associates

Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

TANKS, RUBBER-LINED

The Galigher Co.

TANKS, RUBBER LINED

Denver Equipment Co.—"DENVER"
The Galigher Co.
The Gates Rubber Co.
B. F. Goodrich Industrial Products Co.
Linatex Corp. of America
Raybestos Manhattan Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

TANKS, STEEL

Bethlehem Steel Co.
The Daniels Co.
Denver Equipment Co.—"DENVER"
Enterprise Wheel & Car Corp.
Kanawha Mfg. Co.
Koven Fabricators, Inc.
Phoenix Steel Corp., Structural & Tube Divs.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Wiley Mfg. Co.

TANKS, WOOD

Denver Equipment Co.—"DENVER"
The Hauser-Stander Tank Co.

TAPE, ALUMINUM FOIL

Minnesota Mining & Mfg. Co.—"SCOTCH BRAND NO. 49"

TAPE, BONDING

B. F. Goodrich Industrial Products Co.

TAPE, COATED, POLYESTER MAT

Irvington Div. of Minnesota Mining & Mfg. Co.—"FIBREMAT"

TAPE, COLOR CODING

Plymouth Rubber Co., Inc.—"SLIPKNOT"

TAPE, ELECTRICAL, PLASTIC

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOL-FAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Johns-Manville—"DUTCH BRAND"
Minnesota Mining & Mfg. Co.—"SCOTCH BRAND NO. 33, 22, 21 & 20"
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co.—"SLIPKNOT"
United States Rubber Co.

TAPE, ELECTRICAL, GLASS-CLOTH

Minnesota Mining & Mfg. Co.—"SCOTCH BRAND NO. 27"

TAPE, ELECTRICAL, THERMOSETTING

Minnesota Mining & Mfg. Co.—"SCOTCH BRAND"

TAPE, FRICTION

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOLFAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Guyan Machy. Co.
Jenkins Bros.
Johns-Manville—"4-STAR" "DUTCH BRAND"
Mosebach Electric & Supply Co.
National Electric Co. Div. of McGraw-Edison Co.
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"SLIPKNOT"
The Ruberoid Co.
United States Rubber Co.
West Virginia Armature Co.

TAPE, GLASS-CLOTH

Johns-Manville—"DUTCH BRAND"
National Electric Coil Div. of McGraw-Edison Co.—"MICA-GLAS"

TAPE, GLASS-CLOTH, COATED

Irvington Div. of Minnesota Mining & Mfg. Co.—"FIBRE-MAT"

TAPE, INSULATING, IRRADIATED POLYETHYLENE

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.—"V-C IRRATHANE, MICAMAT"

TAPE, OZONE-RESISTANT

Plymouth Rubber Co., Inc.—"PLYMOZONE"

TAPE, PAPER

Minnesota Mining & Mfg. Co.—"SCOTCH"

TAPE, PLASTIC

Jenkins Bros.

TAPE, POLYETHYLENE

Dayton Industrial Products Co.—"HOLFAST"

TAPE, PRESSURE-SENSITIVE

Johns-Manville—"DUTCH BRAND"

TAPE, RUBBER

Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOLFAST"
Goodall Rubber Co.
Jenkins Bros.
Johns-Manville—"DUTCH BRAND"
Mosebach Electric & Supply Co.
National Electric Coil Div. of McGraw-Edison Co.
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"P. R."
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.
West Virginia Armature Co.

TAPE, VARNISHED-CAMBRIC

Irvington Div. of Minnesota Mining & Mfg. Co.
National Electric Coil Div. of McGraw-Edison Co.
Minnesota Mining & Mfg. Co.—"IRVINGTON," "FIBREMAT," "IVY-BIND," "IRVINGTON" (arc-proofing tapes & blankets)

TAPE, VINYL PLASTIC

Dayton Industrial Products Co.—"HOLFAST"

TAPE, VULCANIZING

American Mine Door Co.

TAPES, MEASURING

Charles Bruning Co., Inc.
Disston Div., H. K. Porter Co., Inc.
Lufkin Rule Co.

TAPS, CABLE & TROLLEY, FUSED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mining Machine Parts, Inc.—"MMP JABCO"
Mosebach Electric & Supply Co.
Ohio Brass Co.
Standard Devices Co.

TARPAULINS

C. R. Daniels Co.
Fulton Cotton Mills—"FULTEX," "FULTON," "SHUREDRY"

TELEPHONES, BATTERY

Crouse-Hinds Co.

TELEPHONES, LOUDSPEAKING MINE

National Mine Service Co.—"FEMCO"

TELEPHONES, SOUND-POWERED

Crouse-Hinds Co.
Mining Progress, Inc.
Wheeler Electronic Corp., Sub. of Sperry Rand Corp.—"WHEELER"

TELEPHONES, TROLLEY

Femco, Inc.
National Mine Service Co.—"FEMCO"

TELEVISION SYSTEMS

Diamond Electronics, Div. of Diamond Power Specialty Corp.—"UTILISCOPE"
General Electric Co., Communication Products Dept.
Motorola Communications & Electronics, Inc.

TEMPERATURE INDICATORS, CONTROLLERS

B-I-F Industries, Inc.—"CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division—"GUARDSMAN-VERI-TELL"
West Instrument Corp.
Westinghouse Electric Corp.

TEST STANDS, HYDRAULIC

Fischer & Porter Co.
Schroeder Brothers Corp.—"UNIVERSAL"

TESTERS, CARBON MONOXIDE

Mine Safety Appliances Co.

TESTERS, INSULATION

The Electrical Distributors Co.
The Hewson Co.—"TAKK," "VON"
Ideal Industries, Inc.
Martindale Electric Co.

TESTERS, INSULATORS

I-T-E Circuit Breaker Co.

TESTERS, PORTABLE HYDRAULIC

Schroeder Brothers Corp.—"PT-50-B"

TESTERS, RAIL-BOND

Mosebach Electric & Supply Co.

TESTERS, RAIL-BOND, INSULATED HANGERS

Ohio Brass Co.

TESTERS, VOLTAGE

Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Holub Industries, Inc.
I-T-E Circuit Breaker Co.
Ideal Industries, Inc.
Martindale Electric Co.
Westinghouse Electric Corp.

THEODOLITES

W. & L. E. Gurley

THEODOLITES, OPTICAL MINING

Kern Instruments, Inc.

THERMOCOUPLES

The Bristol Co.—"BRISTOL'S"
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.

THICKENERS

American Well Works
Denver Equipment Co.—"DENVER-STANDARD," "DENVER HEAVY-DUTY AUTOMATIC"
Dorr-Oliver, Incorporated
The Eimco Corp.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-60
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"

THICKENING, STABILIZING, SUSPENDING AGENTS

B. F. Goodrich Chemical Co.—"GOOD-RITE CARBOPAL 934"

THINNERS, INSULATNG PAINT, VARNISH

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

THROTTLE CONTROLS

Link-Belt Speeder Corp.—"SPEED-O-TROL"

TIES, CROSS, SWITCH

Republic Creosoting Co.

TIMBER—See also Roof Supports, Yieldable Arch

TIMBER, PRESSURE-TREATED

Koppers Co., Inc. Wood Preserving Div. (Creosoted)—"WOLMANIZED"

TIMBER, TREATED

Osmose Wood Preserving Co.

TIMBER, TREATED, UNTREATED

T. J. Moss Tie Co.

TIMBER, YIELDING STEEL PROPS

Mining Progress, Inc.

TIMBER FRAMERS

Denver Equipment Co.—"DENVER"
Stearns-Roger Mfg. Co.

TIMBER PULLERS

Templeton, Kenly & Co.—"SIMPLEX"

TIMBER-TREATING MATERIALS

Darworth, Inc., Chemical Products Div.—"CUPRINOL"
The Dow Chemical Co.
Monsanto Chemical Co.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS, OSMOPLASTICS, M-T-M"

TIMBERING MACHINES

Goodman Mfg. Co.

TIMERS, MERCURY

Durakool, Inc.
Joy Mfg. Co.

TIRE RECAPPING, REPAIRING

Automatic Vulcanizers Corp.

TIRES, MINE

Firestone Tire & Rubber Co.
The General Tire & Rubber Co.
Mitchell Industrial Tire, Inc.—"MITCO TROUBLE FREE"

TIRES, TRUCK & INDUSTRIAL

Dayton Industrial Products Co.—"THOROBRED"
Firestone Tire & Rubber Co.
The Gates Rubber Co.
The General Tire & Rubber Co.
B. F. Goodrich Tire Co., a Div. of The B. F. Goodrich Co.
Goodyear Tire & Rubber Co.
Seiberling Rubber Co.—"POWER LUG," "TRACTION LUG PL"
United States Rubber Co.
W. Va. Belt Repairs, Inc.—"MITCO INDUSTRIAL"

TIRES, STEEL

National Mine Service Co.
Bertrand P. Tracy Co.

TIRES, STEEL TURNING

Leman Machine Co.

TOOLS, ELECTRICAL-CONNECTOR

Burndy Corp.—"HYTOOLS," "HYPRESSES"
Erico Products, Inc.—"CADWELD"
Joy Mfg. Co.

TOOLS, HAND

Guyan Machy. Co.—"PROTO," "CHALLENGER"
Proto Tool Co., Div. of Pendleton Tool Industries, Inc.

TOOLS, HAND, SPARK-RESISTING

Ampco Metal, Inc.

TOOLS, MECHANICS

Bearings, Inc.
Disston Div., H. K. Porter Co., Inc.
Gensco Tools Div., General Steel Warehouse Co., Inc.
Snap-on Tools Corp.

TOOLS, PORTABLE, AIR

Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Marathon Coal Bit Co., Inc.—"BUCKEYE"
Penn Machine Co.
Schramm, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Thor Power Tool Co.
Worthington Corp.

TOOLS, PORTABLE, ELECTRICAL

The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Ingersoll-Rand Co.
Martindale Electric Co.
Penn Machine Co.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
Syntron Co.
Thor Power Tool Co.

TOOLS, POWDER-POWERED

Mine Safety Appliances Co.—"VELOCITY-POWER"
Remington Arms Co., Inc.—"REMINGTON STUD DRIVER"

TOOLS, TRACK

The Aldon Co.
Gibraltar Equipment & Mfg. Co.—GEMCO TRU-BLUE"
The Leetonia Tool Co.

TORCHES & ELECTRODES METAL-REMOVAL

The Arcair Co.

TORQUE CONVERTERS

Clark Equip. Co., Automotive Div.—"CLARK-TORCON"
National Supply Company—"NATIONAL"
Rockwell-Standard Corp., — Transmission and Axle Div. "HYDRA-DRIVE"
Twin Disc Clutch Co.

TORQUE CONVERTERS, INDUSTRIAL

Fuller Mfg. Co.

TOWBOATS

Dravo Corp.
Marietta Manufacturing Co.
Wiley Mfg. Co.

TOWERS, BARGE-UNLOADING

Dravo Corp.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-60
Roberts & Schaefer Company
Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

TOWERS, HYDRAULIC

Mobile Aerial Towers, Inc.—"HI-RANGER"

TOWERS, LOADING

Link-Belt Co., Dept. CAMGL-60

TRACK BRACES

Gibraltar Equipment & Mfg. Co.

TRACK CLEANERS

American Mine Door Co.—"CANTON"

TRACK SHOES, POWER SHOVEL

American Steel Foundries—"WEARPACT"

TRACKWORK

Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

TRACTOR-COMPRESSOR UNITS

Le Roi Div., Westinghouse Air Brake Co.—"TRACTAIR"

TRACTOR GROUSER BARS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

TRACTOR GROUSERS

American Steel Foundries—"WEARPACT"

TRACTOR POWER CONTROL UNITS

Le Tourneau-Westinghouse Co.

TRACTOR GROUSERS, MANGANESE

Kensington Steel, Div. of Poor & Co.

TRACTOR SPROCKET RIMS, MANGANESE

Kensington Steel, Div. of Poor & Co.

TRACTORS, CRAWLER

Allis-Chalmers Mfg. Co.
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.
Diesel Energy Corp.—"DEUTZ"
The Eimco Corp.
Euclid Div., General Motors Corp.
International Harvester Co.
The Oliver Corp.—"OLIVER"

TRACTORS, CRAWLER, UNDERGROUND

Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
The Eimco Corp. (Air or A.C.)
International Harvester Co.
Joy Mfg. Co.

TRACTORS, DOZER

Allis-Chalmers Mfg. Co.

TRACTORS, RUBBER-TIRED MINE

Allis-Chalmers Mfg. Co.
Fred's Welding Service
Kersey Manufacturing Co., Inc.
Long-Airdox Co.
Motor Exchange and Supply Co.

TRACTORS, TRUCK HAULAGE

Autocar Div., The White Motor Co.
FWD Corp.
Henrickson Mfg. Co.
International Harvester Co.
KW-DART Truck Co.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Mack Trucks, Inc.
Reo Div., The White Motor Co.

TRACTORS, WHEELED

Allis-Chalmers Mfg. Co.
Autocar Div., The White Motor Co.
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.
Diesel Energy Corp.—"DEUTZ"
FWD Corp.—"BLUE OX"
The Frank G. Hough Co.
International Harvester Co.
R. G. LeTourneau, Inc.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR"
The Oliver Corp.—"OLIVER"

TRAILER AXLES

Clark Equip. Co., Automotive Div.—"CLARK"
Winter-Weiss Co.

TRAILER BODIES

Baughman Mfg. Co., Inc.
Galion Allsteel Body Co.
Hercules Steel Products Co.
Perfection Steel Body Co.
Winter-Weiss Co.

TRAILERS, FULL, BOTTOM-DUMP

The Heil Co., TEC Div.—"TEC"

TRAILERS, FULL, SIDE-DUMP

The Heil Co., TEC Div.—"TEC"

TRAILERS, FULL, REAR-DUMP

The Heil Co., TEC Div.—"TEC"

TRAILERS, BOTTOM-DUMP

Athey Products Corp.
Euclid Div., General Motors Corp.
Perfection Steel Body Co.
Sanford Day Iron Works, Inc.

TRAILERS, SIDE-DUMP

Athey Products Corp.
Perfection Steel Body Co.
Truck Engineering Corp.

TRAILERS, REAR-DUMP

Athey Products Corp.
Hercules Steel Products Co.
Perfection Steel Body Co.
Truck Engineering Corp.

TRAILERS, SEMI, BOTTOM-DUMP

Hockensmith Corp.
The Heil Co., TEC Div.—"TEC"
KW-Dart Truck Co.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.

TRAILERS, SEMI, SIDE-DUMP

The Heil Co., TEC Div.—"TEC"
Hockensmith Corp.
Marion Metal Products Co.
Perfection Steel Body Co.

TRAILERS, SEMI, REAR-DUMP

The Heil Co., TEC Div.—"TEC," "HY-TEC," "HY-SPILL"
Hercules Steel Products Co.
Hockensmith Corp.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.

TRAMWAY TRACK STRAND, LOCKED COIL

American Steel & Wire Div., United States Steel Corp.

TRANSFER CASES

Clark Equip. Co., Automotive Div.
FWD Corp.
Timken Detroit Axle a Div., Rockwell Spring & Axle Co.
Rockwell-Standard Corp., Transmission & Axle Div.

TRANSFORMER STATIONS, PORTABLE

Ensign Electric & Mfg. Co.

TRANSFORMERS, CONTROL, INSTRUMENT

Allis-Chalmers Mfg. Co.
General Electric Co., Apparatus Sales Div.
Hevi-Duty Electric Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSFORMERS, POWER

Allis-Chalmers Mfg. Co.
Atkinson Armature Works
Delta-Star Electric Div., H. K. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
Hackbridge & Hewittic Electric Co., Ltd.
F. R. Hannon & Sons—"HANCO"
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Kuhlman Elec. Co.
Herbert S. Littlewood
Moloney Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSITS, ENGINEER'S

Gurley, W. & L. E.

TRANSMISSION-BELTING FASTENERS

Crescent Belt Fastener Co. "CRESCENT"

TRANSMISSIONS

Rockwell-Standard Corp., Transmission and Axle Div.—"HYDRA-DRIVE," "POWER-SHIFT"

TRANSMISSION, AUTOMOTIVE

Allison Div., General Motors Corp.—"TORQMATIC" (and fully automatic)
Clark Equip. Co., Automotive Div.—"CLARK"
Fuller Mfg. Co.

TRANSMISSIONS, AUXILIARY

Fuller Mfg. Co.

TRANSMISSIONS, INDUSTRIAL

Clark Equipment Co., Automotive Div.—"CLARK"
Fuller Mfg. Co.

TRANSMISSIONS, POWER SHIFT

Twin Disc Clutch Co.

TRANSMISSIONS, REVERSING

The Snow-Nabstedt Gear Corp.

TRANSMISSIONS, VARIABLE SPEED

Allis-Chalmers Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-60—"P.I.V.," "R.S.V.I.P."
Reeves Pulley Co., Div. The Reliance Electric & Engineering Co.—"VARI-SPEED"

TREADPLATE, ALUMINUM

Aluminum Co. of America

TREADPLATE, ALUMINUM, ABRASIVE

Aluminum Co. of America

TRIP FEEDER-RETARDERS

The Nolan Co.

TRIP HOLDERS

The Nolan Co.

TRIP LAMPS

Concordia Electric Co.—"CEAG"
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Mine Safety Appliances Co.—EDISON R-4"
National Mine Service Co.

TROLLEY CLAMPS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY-CONTACT DEVICES, SLIDE-OPERATED

Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

TROLLEY, CONVEYOR

Link-Belt Co., Dept. CAMGL-60

TROLLEY FROGS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY FROGS, ELECTRIC

Cheatham Elec. Switching Device Co.
Ohio Brass Co.

TROLLEY GUARDS

American Brattice Cloth Corp.
Ensign Electric & Mfg. Co.
John Flocker & Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Guyan Machy. Co.—"VISIGARD"
Mosebach Electric & Supply Co.
National Mine Service Co.
Mine Safety Appliances Co.
Raybestos Manhattan Inc., Manhattan Rubber Div.
United States Rubber Co.

TROLLEY HANGERS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY HARPS, SHOES, SLIDERS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.

TROLLEY, LINE MATERIAL

National Mine Service Co.

TROLLEY POLES, WOOD

Duquesne Mine Supply Co.
Flood City Brass & Electric Co.
J. V. Hammond Co.

TROLLEY-SHOE, CONTACTORS

American Mine Door Co.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
General Equipment & Manufacturing Co.
Mosebach Electric & Supply Co.
Ohio Carbon Co.

TROLLEY SIGNAL SYSTEMS

American Mine Door Co.
General Equipment & Manufacturing Co.
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Ohio Brass Co.
West Virginia Armature Co.

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Ohio Brass Co.

TROLLEY TAPS—See Taps, Cable & Trolley

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Ohio Caroon Co.
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Disston Div., H. K. Porter Co., Inc.

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FWD Corp.

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FWD Corp.

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Revere Copper & Brass, Inc.

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International Harvester Co., Motor Truck Div.—"INTERNATIONAL"
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Irwin Sensenich Corp.
Kanawha Mfg. Co.
National Malleable & Steel Castings Co.—"NATIONAL NC-1"
Sanford Day Iron Works, Inc.

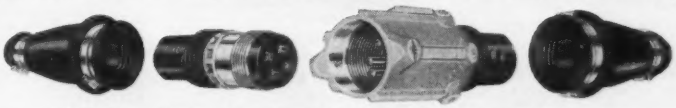
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Penn Machine Co.

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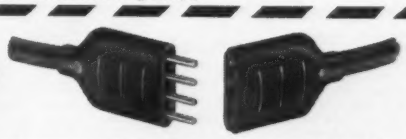


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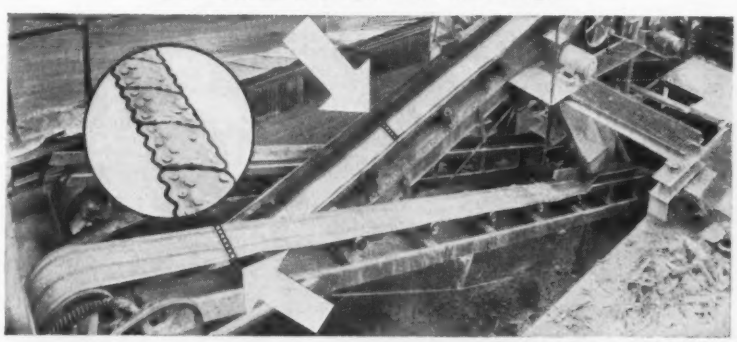
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Taylor-Wharton Co. Div., Harsco Corp.—"TIMANG"
Wall Colmonoy Corp.—"HARD-SURFACING" "COLMONOY"
Westinghouse Electric Corp.

WELDING ELECTRODES, CARBON

Helwig Carbon Products, Inc.
Hobart Bros. Co.
The Lincoln Electric Co.—"E 321" "E 882"
Marathon Coal Bit Co. Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Corp.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Stackpole Carbon Co.

WELDING ELECTRODES, GRAPHITE

Helwig Carbon Products, Inc.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Corp.
Ohio Carbon Co.
Stackpole Carbon Co.

WELDING ELECTRODES, NICKEL, NICKEL ALLOY

International Nickel Co., Inc.

WELDING EQUIPMENT, INERT GAS ARC

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.—"AIRCOMATIC," "HELI-WELD," "AIRCOSPOT"

WELDING-FLUX RECLAIMING SCREENS

Simplicity Engineering Co.

WELDING FLUXES

Eutectic Welding Alloys Corp.—"EUTECTOR FLUXES" "ATMOS FLUX," "AUTO-CHEMIC FLUXES," "EUTECSOL FLUX," "FLOTECTIC FLUXES"
The Lincoln Electric Co.—"LINCOLNWED 760, 780, 781, 840"
Marathon Coal Bit Co. Inc.—"AIRCO"
Rexarc, Inc.—"REXARC"

WELDING FUME EXHAUSTERS

The Arcair Co.

WELDING GASES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
Guyan Machy. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING GOGGLES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
American Optical Co., Safety Products Div.—"NOVIWELD," "DURAWELD"
Bausch & Lomb Optical Co.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Guyan Machy. Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.

Pulmosan Safety Equip. Co.
United States Safety Service Co.

WELDING GROUND CLAMPS

Albert & J. M. Anderson Mfg. Co.
Erico Products, Inc.—"CADDY"
Flood City Brass & Electric Co.
Hobart Bros. Co.
The Lincoln Electric Co.—"GC 300P" "GC 500"
Marathon Coal Bit Co., Inc.—"AIRCO"
Ohio Brass Co.—"KLIPLOK"
Trico Fuse Mfg. Co.
Tweco Products, Inc.—"TWECO"

WELDING HELMETS

American Optical Co., Safety Products Div.—"WELD COOL"
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Guyan Machy. Co.
Hobart Bros. Co.
The Lincoln Electric Co.—"COMFORT SHIELD," "LPH," "FMH"
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

WELDING HOLDERS

Flood City Brass & Electric Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING HOSE

Acme-Hamilton Rubber Mfg. Corp.—"STAPLE"
Carlyle Rubber Co., Inc.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hewitt-Robins Incorporated—"TWIN-WELD"
Marathon Coal Bit Co. Inc.—"AIRCO"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.

WELDING PLUGS

Tweco Products, Inc.

WELDING PLUGS, ELECTRICAL

Joy Mfg. Co.

WELDING POSITIONERS

Harnischfeger Corp.
Rexarc, Inc.—"REXARC"

WELDING RECTIFIERS

Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING ROD, WIRE

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

WELDING SHIELDS

American Optical Co., Safety Products Div.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Hobart Bros. Co.
Marathon Coal Bit Co., Inc.—"AIRCO"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

WELDING SURFACE PROTECTION COMPOUND

The Arcair Co.

WELDING TRANSFORMERS

Guyan Machy. Co.—"M & T"
Hobart Bros. Co.
The Lincoln Electric Co.—"IDEALARC," "LINC-WELDER"
Marathon Coal Bit Co. Inc.—"AIRCO"
Westinghouse Electric Corp.

WELDING-TUBE FITTINGS

Parker Fittings & Hose Div., Parker-Hannifin Corp.—"WELD-LOK"

WELDING WIRE

Drawalloy Corp.—"DRAW-ALLOY"
Lukens-Steel Co.—"LUKENS PLATE MATE"
The McKay Co.—"McKAY TUBE-ALLOY" (automatic and semi-automatic)

WELDING WIRE, AUTOMATIC

Rexarc, Inc.—"REXARC"

WELDMENTS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
Connellsville Mfg. & Mine Supply Co.
The Falk Corp.
Farrel-Birmingham Co., Inc.
Koven Fabricators, Inc.
Meckum Engineering, Inc.
Phoenix Steel Corp., Structural & Tube Divs.
Sanford Day Iron Works, Inc.

WELDMENTS, CAST

Electric Steel Foundry Co.

WETTING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals Depts.—"AEROSOL®"
American Minechem Co.

WHEELBARROWS

The Wood Shovel & Tool Co.

WHEELBARROWS, POWERED

Prime Mover Co.—"15B"

WHEEL EXCAVATORS

Bucyrus-Erie Co.
Link-Belt Co., Dept. CAMGL-60—"LMG," "LINK-BELT"

WHEELS, LOCOMOTIVE, CAST-IRON

American Car & Foundry Div., ACF Industries, Inc.
The Ironton Engine Co.—"IRON-TON"
Irwin Sensenich Corp.

WHEELS, LOCOMOTIVE, STEEL

Bethlehem Steel Co.
Farrell-Cheek Steel Co.
The Ironton Engine Co.—"IRON-TON"
Pittsburgh Gear Co.
Sterling Steel Casting Co.

WHEELS, LOCOMOTIVE, STEEL REBUILT

Leman Machine Co.

WHEELS, MACHINE-TRUCK

Enterprise Wheel & Car Corp.
Irwin Sensenich Corp.
United States Rubber Co.

WHEELS, MINE-CAR

Farrell-Cheek Steel Co.
Link-Belt Co., Dept. CAMGL-60

WHEELS, MINE-CAR, CAST-IRON

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibralter Equipment & Mfg. Co.—"GEMCO TRU-BLU"
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
McLanahan & Stone Corp.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

WHEELS, MINE-CAR, MANGANESE

Kensington Steel, Div. of Poor & Co.

WHEELS, MINE-CAR, STEEL

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Gibralter Equipment & Mfg. Co.—"GEMCO TRU-BLU"
Irwin-Sensenich Corp.
National Malleable & Steel Castings Co.—"NACO"
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

WINCHES

Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Clyde Iron Works, Inc.
Cowanesque Valley Iron Works
Gar Wood Industries, Inc.
Hewitt-Robins Incorporated
Ledeen Mfg. Co.
Link-Belt Co., Dept. CAMGL-60
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Tulsa Winch Div. of Vickers, Inc.—"TULSA"

WINCHES, AIR

Joy Mfg. Co.

WINCHES, PIPE DRIVING

Sprague & Henwood, Inc.

WIRE

Republic Steel—"REPUBLIC"

WIRE, ARMATURE BANDING, STAINLESS, CARBON STEEL

Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, ELECTRICAL—See Also Cable

WIRE, ELECTRICAL, BARE

American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
—Rome Cable, Div. of Alcoa

WIRE, ELECTRICAL, INSULATED

American Steel & Wire Div., U.S. Steel Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD" "ALUMOWELD"
Cornish Wire Co., Inc.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Wire and Cable Dept., Conduit Products Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales Inc.
National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Wire & Cable Co., Div. of Cerro de Pasco Corp.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Rome Cable, Div. of Alcoa
Simplex Wire & Cable Co.

WIRE, FEEDER

Aluminum Company of America
American Steel & Wire Div., U.S. Steel Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
John Flocker & Co.
General Cable Corp.
General Electric Co., Wire & Cable Dept., Conduit Products Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
Phelps Dodge Copper Products Co.
Rome Cable, Div. of Alcoa

WIRE, SHAPED

Bethlehem Steel Co.
Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, SHOTFIRING

American Steel & Wire Div., U.S. Steel Corp.
Circle Wire & Cable Corp.
Cornish Wire Co., Inc.
John Flocker & Co.
General Cable Corp.
General Electric Co., Wire and Cable Dept., Conduit Products Dept.
Kaiser Aluminum & Chemical Sales, Inc.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Phelps Dodge Copper Products Co.
Rome Cable, Div. of Alcoa

WIRE, TELEPHONE

American Steel & Wire Div., U.S. Steel Corp.—"AMER-TEL"
Bethlehem Steel Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
—"ACCOALUMINIZED"
National Electric Products Co.
Okonite Co.
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.

WIRE, THERMOCOUPLE

West Instrument Corp.

WIRE, TROLLEY

Aluminum Co. of America
American Steel & Wire Div., U.S. Steel Corp.
Anaconda Wire & Cable Co.
John Flocker & Co.
General Cable Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Phelps Dodge Copper Products Co.
—John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.

WIRE CLOTH

Hewitt-Robins Incorporated—"GYRALOY," "SUPER-GYRALOY"
Hoyt Wire Cloth Co.—"SUPER-TOUGH," "ABRASO," "SUPERHARD STAINLESS STEEL," "SMOOTH TOP," "LONG-SLOT," "OBLONG" "DOUBLE CRIMP"
Ludlow Saylor Wire Cloth Co.
W. S. Tyler Co.

WIRE ENAMELS

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

WIRE ROPE

American Chain & Cable—"LAY-SET," "TRU-LAY," "VHS"
American Steel & Wire Div., U.S. Steel Corp.—"TIGER BRAND"
Bergen Wire Rope Co.
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND" "POWERSTEEL"
The Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WICKWIRE" "DOUBLE GRAY-X"
John Flocker & Co.
Flood City Brass & Electric Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"HERCULES RED STRAND," "PORTER IMPERIAL RED STRAND"
LeTourneau-Westinghouse Co.—"TOUNAROPE"
Macwhyte Wire Rope Co.—"WHYTE STRAND," "MAC-WHYTE" "MONARCH" "PREMIUM" "HI-LASTIC" "HI-FATIGUE"
Marathon Coal Bit Co. Inc.—"BETHLEHEM," "MACWHYTE"
Mosebach Electric & Supply Co.
National Mine Service Co.
Kurt Orban Co., Inc., Industrial Equipment Div.
Rochester Ropes, Inc.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
W. J. Savage Co.
Union Wire Rope Corp. Sub of Armco Steel Corp.—"TUFFY"
The Upson-Walton Co.
West Virginia Armature Co.
Wire Rope Corp. of America, Inc.—"WIRECO" "BROWN STRAND"

WIRE-ROPE CONDUCTOR-CORE

American Chain & Cable—"SIGNALKORE"

WIRE ROPE, PLASTIC COATED
Rochester Ropes, Inc.

WIRE ROPE, STAINLESS STEEL, MONEL METAL, PLASTIC COATED AND NYLON COATED
Macwhyte Wire Rope Co.

WIRE ROPE, SWING TAIL, CAR-PULLER
The Upson-Walton Co.

WIRE ROPE BOOM PENDANTS
Bethlehem Steel Co.
Union Wire Rope Corp., Sub. of Armco Steel Corp.

WIRE-ROPE CLAMPS
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.—"JALKAMPS"
Marathon Coal Bit Co. Inc.—"BETHLEHEM"
Mosebach Electric & Supply Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
Union Wire Rope Corp., Div. of Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE CLIPS
American Chain & Cable—"ACCO CLIPS"
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.—"ALTCO"
Broderick & Bascom Rope Co.—"YELLOW STRAND"
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY"
Ensign Electric & Mfg. Co.
Farrell-Cheek Steel Co.
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
Marathon Coal Bit Co., Inc.—"BETHLEHEM"
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Union Wire Rope Corp., Div. of Armco Steel Corp.
The Upson-Walton Co.—"GOLD CLIP"
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE EYES
American Chain & Cable
John Flocker & Co.
Jones & Laughlin Steel Corp.
Joy Mfg. Co.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.

WIRE-ROPE FITTINGS
American Steel & Wire Div., U.S. Steel Corp.
Farrell-Cheek Steel Co.
Rochester Ropes, Inc.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE LUBRICANTS
Ashland Oil & Refining Co.—"VALVOLINE-ASHLAND"
Cities Service Oil Co.
Esso Standard, Div. of Humble Oil and Refining Co.—"SURETT," "SURRETT FLUIDS," "COBLAX"
John Flocker & Co.
Hulburt Oil & Grease Co.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Wire Rope Co.
Mobile Oil Co., A Div. of Socony Mobil Oil Co., Inc.
New York & New Jersey Lubricant Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Shell Oil Co.
Swan-Finch Petro Chemicals
Texaco Inc.
The Whitmore Mfg. Co.

WIRE-ROPE SHACKLES
American Chain & Cable
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Union Wire Rope Corp., Div. of Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE SLINGS
Bethlehem Steel Co.
Guyan Machinery Co.
Rochester Ropes, Inc.

WIRE-ROPE SOCKETS
American Chain & Cable
The Bowdil Co.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
Farrell-Cheek Steel Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
Mosebach Electric & Supply Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Sauerman Bros., Inc.
Union Wire Rope Corp. Div. of Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE SWAGED ASSEMBLIES
American Chain & Cable—"TRU-LOC"
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"BROLOC"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
W. J. Savage Co.
Union Wire Rope Corp., Div. of Armco Steel Corp.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE SWIVELS
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
The Upson-Walton Co.

WIRE-ROPE THIMBLES
Crosby-Laughlin Div. American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Farrell-Cheek Steel Co.
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
The Upson-Walton Co.
Union Wire Rope Corp., Div. of Armco Steel Corp.

WIRE STRIPPERS
Martindale Electric Co.

WIRING DEVICES
Arrow Hart & Hegeman Electric Co.
The Elreco Corp.
Holub Industries, Inc.
National Electric Products Co.
United States Rubber Co.

WOOD PRESERVATIVES
Darworth, Inc., Chemical Products Div.—"CUPRINOL"
The Dow Chemical Co.
E. I. du Pont de Nemours & Co., Inc. ("CZC" Chromated Zinc Chloride)
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS," "OSMOPLASTIC," "M-T-M"
The Wilbur & Williams Co. Inc.—"PERMODIP"

WRENCHES, BIT
Duquesne Mine Supply Co.
Guyan Machy. Co.
Joy Mfg. Co.
The Leetonia Tool Co.
Marathon Coal Bit Co. Inc.—"MARATHON," "PROTO"
North American Gear Co. (reversible ratchet)
Frank Prox Company Inc.
Bertrand P. Tracy Co.

WRENCHES, HOPPER
Advance Car Mover Co., Inc.—"ADVANCE SAFETY"

WRENCHES, IMPACT
The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Marathon Coal Bit Co. Inc.—"PROTO"
Penn Machine Co.
Remington Arms Co., Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Thor Power Tool Co.

WRENCHES, SET SCREW
The Leetonia Tool Co.

WRENCHES, TORQUE
Bearings, Inc.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Marathon Coal Bit Co. Inc.—"PROTO"
Proto Tool Co., Div. of Pendleton Tool Industries, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.

WRENCHES, TRACK
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.

WROUGHT-IRON BARS, SHAPES, TUBING
A. M. Byers Co.

YO-YOS, ELECTRIC
The Nolan Co.

YO-YOS, HYDRAULIC
The Nolan Co.
Schroeder Brothers Corp.
W. R. Stamler Corp.

YO-YOS, HYDRAULIC, REBUILT
Leman Machine Co.

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Directory of Manufacturers

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ABCRs Scale Div., McDowell Co., Inc., 113 St. Clair Ave. N.E., Cleveland 14, Ohio
Acker Drill Co. Inc., P.O. Box 830, Scranton, Pa.
Acme Chain Corp., 821 Main St., Holyoke, Mass.
Acme Electric Corp., 2009 Water St., Cuba, N. Y.
Acme-Hamilton Mfg. Corp., Meade St., Trenton, N.J., ADV. p371
Acme Machinery Co., Box 2409 Huntingdon, W. Va.
Advance Car Mover Co., Inc., Box 536, Appleton, Wis.
Aerial Surveys, Inc., 4614 Prospect Ave., Cleveland, Ohio
Aero Service Corp., 210 East Courtland St., Philadelphia 20, Pa.
Aeroquip Corp., 300 S. East Ave., Jackson, Mich., ADV. p401
Ahlberg Bearing Co., 3025 West 47 St., Chicago 32, Ill.
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc., 150 East 42nd St., New York 17, N. Y.
Airmite-Midwest, Inc., 119 North Chestnut St., DuQuoin, Ill.
Ajax Flexible Coupling Co. Inc., 17 English St., Westfield, N. Y.
The Aldon Co., 3338 Ravenswood Ave., Chicago 13, Ill.
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Allegheny Ludlum Steel Corp., Carmet Div., 1500 Jarvis Ave., Detroit 20, Mich., ADV. p33
Allen & Garcia Co., 322 South Michigan Ave., Chicago 4, Ill., ADV. p132-133
The Allen-Sherman-Hoff Pump Co., P. O. Box 635, Paoli, Pa.
Allied Chemical Corp., Nitrogen Div., 40 Rector St., New York 6, N. Y.
Allied Chemical Corp., Solvay Process Div., 61 Broadway, New York 6, N. Y., ADV. p44
Allis-Chalmers Mfg. Co., 986 South 70 St., Milwaukee 1, Wis.
The Louis Allis Co., 427 E. Stewart St., Dept. P, Milwaukee 1, Wis.
Allison-Campbell Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.
Allison Div., General Motors Corp., 4700 W. 10th St., Indianapolis, Ind.
Alloy Rods Co., York, Pa., ADV. p65
Alloy Steel Castings Co., 205 County Line Rd., Southampton, Pa.
Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa., ADV. p178-179
Amercoat Corp., 4809 Firestone Blvd., South Gate, Calif.
American Air Filter Co., Inc., 267 Central Ave., Louisville 8, Ky.
American Air Surveys, Inc., 907 Penn Ave., Pittsburgh 22, Pa.
American Alloy Corp., 8885 E. 78th St., Cleveland 5, Ohio
American Brake Shoe Co., American Brakeblok Div., P. O. Box 21, Birmingham, Mich.
American Brake Shoe Co., National Bearing Div., 717 Grant Bldg., Pittsburgh 19, Pa.
American Brake Shoe Co., Railroad Products Div., 530 Fifth Ave., New York 36, N. Y.
American Brattice Cloth Corp., 200 Argonne Rd., Warsaw, Ind., ADV. p403
American Bridge Div., U. S. Steel Corp., 204 Frick Bldg., Pittsburgh 30, Pa.
American Car & Foundry Div., ACF Industries, Inc., 730 Third Ave., New York 17, N. Y., ADV. p21
American Chain & Cable, Wilkes Barre, Pa.
American Chain Div., American Chain & Cable Co., Inc., E. Princess & Charles Sts., York, Pa.
American Conveyor Co., 2133-37 S. Christiana Ave., Chicago 23, Ill.
American Crucible Products Co., 1305 Oberlin Rd., Lorain, Ohio
American Cyanamid Co., Explosives and Mining Chemicals Dept., 30 Rockefeller Plaza, New York 20, N. Y., ADV. p20
American Engineering Co., Div. of United Industrial Corp., Wheatsheaf Lane & Sepviva St., Philadelphia 37, Pa.
American Enka Corp., 530 Fifth Ave., New York 36, N. Y.
American Hoist & Derrick Co., 63 South Robert St., St. Paul 7, Minn.
American LaFrance, Div. of Sterling Precision Corp., 100 East LaFrance St., Elmira, N. Y.
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
American Manganese Steel Div., American Brake Shoe Co., Chicago Heights, Ill.
American MARC Inc., 1601 West Florence Ave., P. O. Box 549, Inglewood, Calif.
American-Marsh Pumps, Inc., 59 Capitol Ave., N. E., Battle Creek, Mich.
American Mine Door Co., 2057 Dueber Ave., S. W., Canton 6, Ohio, ADV. p163
American Mine Supply Co., 404 Frick Bldg., Pittsburgh 19, Pa.
American Minechem Co., P. O. Box 231, Coraopolis, Pa.
The American Oil Co., 555 Fifth Ave., New York 17, N. Y., ADV. p55
American Optical Co., Safety Products Div., 89 Mechanic St., Southbridge, Mass.
American Paulin System, 1524 South Flower St., Los Angeles 15, Calif.
The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo., ADV. p68
American-Standard Industrial Div., Detroit 32, Mich.
American Steel Foundries, 3761 Canal St., East Chicago, Ind.
American Steel & Wire Div., United States Steel Corp., Rockefeller Bldg., Cleveland 13, Ohio.
American Well Works, 162 North Broadway, Aurora, Ill.
Jack Ammann, Inc., Engineers & Surveyors, 931 Broadway, San Antonio 5, Texas
Ampco Metal, Inc., 1723 South 38 St., Milwaukee 1, Wis.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y., ADV. p106-107
Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Coupling Co., Inc., 342 No. Fourth St., Libertyville, Ill.
Anchor Packing Co., 401 North Broad St., Philadelphia 8, Pa.
Albert & J. M. Anderson Mfg. Co., 289 A St., Boston 10, Mass.
The Ansonia Wire & Cable Co., 111 Martin St., Ashton, R. I.
Ansul Chemical Co., Marinette, Wis.
The Arcair Co., P. O. Box 431, Lancaster, Ohio
Armco Drainage & Metal Products, Inc., 6770 Curtis St., Middletown, Ohio
Armstrong, Bray & Co., 5364 Northwest Hwy., Chicago 30, Ill.
Aro Equipment Corp., Bryan, Ohio
Arrow Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford 6, Conn.
Arrowhead Engineers and Constructors, Inc., 1122 W. Railroad St., Duluth 2, Minn.
Ashland Oil & Refining Co., Ashland, Ky., ADV. p187
Athey Products Corp., 5631 W. 65 St., Chicago 38, Ill.
Atkinson Armature Works, 116 E. 1st St., Pittsburg, Kan.
Atlas Powder Co., Wilmington 99, Del., ADV. p160-161
Auburn Foundry, Inc., Heating Div., Auburn, Ind.
Aurora Pump Div., The New York Air Brake Co., 619 Loucks St., Aurora, Ill.
Austin Powder Co., Rockefeller Bldg., Cleveland 13, Ohio
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp., 601 N. Farnsworth Ave., Aurora, Ill., ADV. p72
Autocar Div., The White Motor Co., Exton, Pa.
Automatic Vulcanizers Corp., 16 Hudson St., New York, 13, N. Y. ADV. p373
Automation Products, Inc., 3030 Max Roy St., Houston 24, Texas
Axeman-Anderson Co., 233 West St., Williamsport 3, Pa.

B

Baldwin-Lima-Hamilton Corp., Construction Equipment Div., South Main St., Lima, Ohio.
Baltimore & Ohio R.R., Baltimore 1, Ohio
Bando Rubber Mfg. Co., Ltd., 1.2-Chome, Meiwa-dori, Hyogoku, Kobe, Japan
Bantam Bearings Div., Torrington Co., 3702 West Sample St., South Bend 21, Ind.
Barber-Greene Co., 400 N. Highland Ave., Aurora, Ill.
Barkadale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.
Barnes Mfg. Co., 615 N. Main St., Mansfield, Ohio
Barrett, Haentjens & Co., Hazleton, Pa.
Baton & Co., Geo. S., 1100 Union Trust Bldg., Pittsburgh 19, Pa.
Baughman Mfg. Co., Inc., Shipman Rd., Jerseyville, Ill.
Bausch & Lomb Optical Co., 80460 Bausch St., Rochester 2, N. Y.
Bearing Service Co., 4650-52 Baum Blvd., Pittsburgh 13, Pa.
Bearings, Inc., 3634 Euclid Ave., Cleveland, Ohio
Bemis Bro. Bag Co., 408 Pine St., Dept. B, St. Louis 2, Mo.
Bergen Wire Rope Co., 151 Gregg St., Lodi, N. J.
C. L. Berger & Sons, Inc., 37 Williams St., Boston 19, Mass.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Steel Co., 701 East Third St., Bethlehem, Pa., ADV. p8, 99, 137
B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.
Bigelow-Liptak Corp., 13300 Puritan Ave., Detroit 27, Mich.
The Bin-Dicator Co., 13946-32 Kercheval Ave., Detroit 15, Mich.
Bird Machine Co., South Walpole, Mass., ADV. p4
Bituminous Casualty Corp., Bituminous Bldg., 320 18th St., Rock Island, Ill.
Bixby-Zimmer Engineering Co., 961 Abington St., Galesburg, Ill., ADV. p391
The Black & Decker Mfg. Co., Towson 4, Md.
Black Diamond Spad Co., 3108 Stratford Rd., Richmond 25, Va.

Blackhawk Industrial Div., N57 W. 13264 Reichert Ave., Butler, Wis.
Blaw-Knox Co., Blaw-Knox Equipment Div., Pittsburgh 38, Pa.
Boston Woven Hose & Rubber Co., Div. of American Biltrite Rubber Co. P.O. Box 1071, Boston 3, Mass., ADV. p89
The Bowdil Co., Boylan Ave., S.E., Canton, Ohio. ADV. pp12, 13
The Branford Co., 132 Glen St., New Britain, Conn.
The Bristol Co., P.O. Box 1790 CA, Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo., ADV. p188
The Brooks Oil Co., 3304 East 87th St., Cleveland 27, Ohio
Brookville Locomotive Works, Steele Blvd., Brookville, Pa.
Browning Mfg. Co., Maysville, Ky.
Charles Bruning Co., Inc., Mount Prospect, Ill.
Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.
Brunner & Lay-Eastern, Inc., 2514-16 E. Cumberland St., Philadelphia 25, Pa.
Bucyrus-Erie Co., South Milwaukee, Wis.
Buffalo Forge Co., 490 Broadway, Buffalo 5, N.Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N.Y.
Buffalo-Springfield Co., Div. of Koehring Co., 1100 Kenton St., Springfield, Ohio
E. D. Bullard Co., 2680 Bridgeway, Sausalito, Calif.
Burndy Corp., Richards Ave., Norwalk, Conn.
Bussmann Mfg. Div., McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.
Buttner Works, Inc., 52 Vanderbilt Ave., New York 17, N.Y.
A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp., P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

C

C & D Batteries, Div. The Electric Autolite Co., Conshohocken, Pa.
Cable Vulcanizing Shop, Inc., P. O. Box 126, Pecks Mill, W. Va.
Samuel Cabot Inc., 246 Summer St., Boston 10, Mass.
E. K. Campbell Co., 1809 Manchester Ave., Kansas City 26, Mo.
Canton Stoker Corp., 741 Andrew Place, S. W. Canton, Ohio
C. S. Card Iron Works, P.O. Box 117, Denver 1, Colo.
Philip Carey Mfg. Co., Cincinnati 15, Ohio
Carlon Products Corp., Box 133, Aurora, Ohio
Carlyle Rubber Co., Inc., 103-107 Warren St., New York 7, N.Y.
Carpenter Heating & Air Conditioning Co., 2135 St. Clair Ave., Cleveland, Ohio.
Carrier Conveyor, Div. Chain Belt Co., 211 N. Jackson St., Louisville 2, Ky., ADV. p54
Carver Pump Co., Muscatine, Iowa
J. I. Case Co., 700 State St., Racine, Wis.
A. W. Cash Co., P.O. Box 551, Decatur, Ill.
A. W. Cash Valve Mfg. Corp., 666 E. Wabash, Decatur, Ill.
Caterpillar Tractor Co., Peoria, Ill., ADV. pp18-19, 173, 363, 376
Cement Gun Co., 1620 Walnut St., Allentown, Pa.
Central Mine Equipment Co., 6200 N. Broadway, St. Louis 15, Mo.
Central Mine Supply Co., Div. Pickard Industries, Inc., Mt. Vernon, Ill.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18 Mo., ADV. p151
Chain Belt Co., 4786 W. Greenfield Ave., Milwaukee 1, Wis.
Chain Belt Co., Shafer Bearing Div., P.O. Box 57, Downers Grove, Ill.
Champ Industries Inc., P. O. Box 6781, Philadelphia 32, Pa.
Chase Bag Co., 355 Lexington Ave., New York 17, N.Y.
Cheatham Elec. Switching Device Co., 4780 Crittenden Dr., Louisville 9, Ky., ADV. p384
Chelsea Fan and Blower Co., Inc., 639 South Ave., Plainfield, N.J.
Chevrolet Motor Div., General Motors Bldg., Detroit 2, Mich.
Chicago Eye Shield Co., 2727 W. Roscoe St., Chicago 18, Ill.
Chicago Perforating Co., 2445 West 24 Pl., Chicago 8, Ill.
Chicago Pneumatic Tool Co., 8 East 44 St., New York, N.Y., ADV. p143
Chiksan Co., 330 N. Pomona Ave., Brea, Calif.
J. D. Christian Engineers, 480 Potrero Ave., San Francisco 10, Calif.
The Cincinnati Electrical Tool Co., 300 Mt. Hope Ave., Cincinnati 4, Ohio.
Cincinnati Mine Machinery Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio
Cincinnati Rubber Mfg. Co., Div., of Thor Power Tool Co., Franklin Ave., Cincinnati 12, Ohio
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth 78, N.Y., ADV. p184-185
Circuit Protective Devices Dept., General Electric Co., 41 Woodford Ave., Plainville, Conn.
Cities Service Oil Co., 60 Wall Tower, New York 5, N.Y.
Clarage Fan Co., 1 Clarage Pl., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio
Clark Equipment Co., Construction Machinery Div., P.O. Box 599, Benton Harbor, Mich.
Clark Equipment Co., Automotive Div., Buchanan, Mich.
Clayton Manfacturing Co., P.O. Box 550, El Monte, Calif.
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland, Ohio
Cleveland Wire Cloth & Mfg. Co., 3573 E. 78th St., Cleveland 5, Ohio, ADV. p174
Cleveland Worm & Gear Div., Eaton Mfg. Co., 3300 East 80 St., Cleveland 4, Ohio
Clyde Iron Works, Inc., Duluth, Minn.
Coast Metals, Inc., 201 Redneck Ave., Little Ferry, N.J.
Cobra Metal Hose, Div. DK Mfg. Co., 5059 S. Kedzie Ave., Chicago 32, Ill.
Coffing Hoist Div., Duff-Norton Co., 800 Walter St., Danville, Ill.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R.I., ADV. p57
The Colorado Fuel and Iron Corp., Continental Oil Bldg., Denver, Colo.; Wickwire Spencer Steel Div., 575 Madison Ave., New York 22, N.Y.
Columbia-Southern Chemical Corp., One Gateway Center, Pittsburgh 22, Pa.
Columbus McKinnon Chain Corp., Mining Equipment Div., Tonawanda, N.Y., ADV. p157
Combustion Engineering, Inc., 200 Madison Ave., New York 16, N.Y.
Combustion Engineering, Inc., Raymond Div., 1132 W. Blackhawk St., Chicago 22, Ill., ADV, p108
The Commercial Shearing & Stamping Co., 1775 Logan Ave., P.O. Box 239, Youngstown 1, Ohio
Commercial Testing & Engineering Co., Suite 924, 228 North La Salle St., Chicago 1, Ill.
Compton, Inc., P.O. Box 1946, Clarksburg, W. Va.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
Cone-Drive Gears Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
R. Conrader Co., Inc., 236 West 17th St., P.O. Box 924, Erie, Pa.
Construction Machy. Co., P.O. Box 120, Waterloo, Iowa
Continental Conveyor & Equipment Co., Winfield, Ala.
Continental Rubber Works, 1933 Liberty St., Erie 6, Pa.
Convair, P.O. Box 9671, Pittsburgh 26, Pa.
Cooke-Wilson Electrical Supply Co., 1787 North Highland, Pittsburgh 28, Pa.
Copperweld Steel Co., Wire & Cable Div., Glassport, Pa.
Coppus Engineering Corp., 344 Park Ave., Worcester 10, Mass.
Corhart Refractories Co., Sub. of Corning Glass Works, 940 Commonwealth Bldg., Louisville 2, Ky.
Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., South Plainfield, N.J.
Cornish Wire Co., Inc., 50 Church St., New York 7, N.Y.
Cowanesque Valley Iron Works, 960 Elm St., Cowanesque, Pa.
Cowin & Co., Inc., 1 18th St., SW, Birmingham, Ala.
Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
Crescent Belt Fastener Co., 381 Fourth Ave., New York 16, N.Y., ADV. p409
Crosby-Laughlin Div., American Hoist & Derrick Co., Fort Wayne 1, Ind.
Cross Perforated Metals Plant, National Standard Co., Carbondale, Pa.
Crouse-Hinds Co., Syracuse 1, N.Y.
Crucible Steel Co. of America, P. O. Box 2518, Pittsburgh 30, Pa.
Cummins Engine Co. Inc., Columbus, Ind., ADV. pp37, 38-39, 40-41, 42
Cutler-Hammer, Inc., 220 N. 12th St. Milwaukee 1, Wis.
Cutter Bit Service Co., 111 West 8th Ave., P.O. Box 533, Huntington, W. Va.

D

D-A Lubricant Co., Inc., 1331 West 29 St., Indianapolis 23, Ind.
Dallas Engineers, Inc., Coal-O-Matic Div., Main St., Trucksville, Pa.
Daly Ticket & Printing Co., 506-08 Vandalia St., Collinsville, Ill.
The Dana Fan & Blower Corp., Gen Offices—49 Central Ave., Cincinnati 2, Ohio; Plant—2644 Colerain Ave., Cincinnati 14, Ohio
C. R. Daniels Co., Daniels, Md.
The Daniels Co., The Daniels Bldg., Bluefield, W. Va.
Darworth Incorporated, Chemical Products Div., Simsbury, Conn.
Davey Compressor Co., 600 Franklin Ave., Kent, Ohio
Nelson L. Davis Co., 517 Main St., McHenry, Ill.
Day-Ray Products, Inc., 1133 Missions St., South Pasadena, Calif.
Dayton Automatic Stoker Co., 1910 W. Dorothy Lane, Box 2186, Kettering Branch, Dayton 29, Ohio
Dayton Industrial Products Co., 2001 Janice Ave., Melrose Park, Ill.
Dean Brothers Pumps Inc., 323 West 10th St., Indianapolis 7, Ind.
The Deister Concentrator Co., Inc., 903 Glasgow Ave., Ft. Wayne 1, Ind., ADV. p36
Deister Machine Co., 1933 E. Wayne St., Ft. Wayne 4, Ind.
Delta-Star Electric Div., H. K. Porter Co., Inc., 2437 Fulton St., Chicago 12, Ill.
The Deming Co., Salem, Ohio
Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio
Denver Equipment Co., P. O. Box 5628, Denver 17, Colo., ADV. p31
Detroit Controls Div., American-Standard, 5900 Trumbull Ave., Detroit 8, Mich.
Diamond Chain Co., Inc., 402 Kentucky Ave., Indianapolis 7, Ind.
Diamond Crystal Salt Co., St. Clair, Mich.
Diamond Electronics, Div. of Diamond Power Specialty Corp., Lancaster, Ohio
Diamond Iron Works, Div. Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Diamond Tool Research Co., Inc., 380 Second Ave., New York 10, N.Y.
Diehl Mfg. Co., 1208 Finderne Ave., Somerville, N.J.
Diesel Energy Corp., 82 Beaver St., New York, N.Y.
Differential Steel Car Co., Differential Ave., Findlay, Ohio, ADV. p172
Dings Magnetic Separator Co. 4724 W. Electric Ave., Milwaukee 46, Wis.
Disston Div., H. K. Porter Co., Inc., Philadelphia 35, Pa.
Joseph Dixon Crucible Co., Monmouth & Wayne Sts., Jersey City 3, N.J.
Dodge Div., Chrylser Corp., 7900 Jos. Campau, Detroit 31, Mich.
Dodge Mfg. Corp., South Union St. Mishawaka, Ind.
Dominick & Dominick, 14 Wall St., New York 5, N.Y.
Dooley Brothers, 1201 S. Washington St., Peoria, Ill.
Dorr-Oliver Incorporated, 77 Havemeyer Lane., Stamford, Conn.
The Dow Chemical Co., Midland, Mich., ADV. p154
Dow Corning Corp., Midland, Mich.
Dowty Mining Equipment Ltd., Ashchurch, Gloucestershire, England, ADV. pp 46-47
Dravo Corp., Neville Island, Pittsburgh 25, Pa., ADV. p17
Drawalloy Corp., Lincoln Highway West at Alloy St., York, Pa.
Dresser Mfg. Div., Dresser Industries, Inc., 450 Fisher Ave., Bradford, Pa.
The Ducon Co., Inc., 154 E. Second St., Mineola, N.Y.
Duff-Norton Co., P.O. Box 1719, Charlotte 1, N.C.
E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del., ADV. pp58, 139
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 North Main St., Elkhart, Ind.
The Duriron Co., Inc., 450 North Findlay St., Dayton 4, Ohio
Dynamatic Div., Eaton Mfg. Co., 3122 Fourteenth Ave., Kenosha, Wis.

E

Eagle Iron Works, 161 Holcomb Ave., Des Moines 4, Iowa.
Eastern Sales Co., Div. of Eastern Malleable Iron Co., 4700 Clairton Blvd., Pittsburgh 36, Pa.
Eaton Mfg. Co., Axle Div., 739 East 140th St., Cleveland 10, Ohio
Eavenson, Auchmuty & Greenwald, 2320 Koppers Bldg., Pittsburgh 19, Pa.
Economy Fuse Div., Federal Pacific Electric Co., 2717 N. Greenview Ave., Chicago 14, Ill.
Thomas A. Edison Industries, McGraw-Edison Co., Storage Battery Div., West Orange, N.J.
The Eimco Corp., 630 South 4th West St., Salt Lake City 10, Utah
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N.J.
Electric Machinery Mfg. Co., 800 Central Ave., Minneapolis 13, Minn.
Electric Products Co., 1725 Clarkstone Rd., Cleveland 12, Ohio
Electric Steel Foundry Co., 2141 N. W. 25th Ave., Portland 10, Oregon
The Electrical Distributors Co., Penn Square Building, Philadelphia 7, Pa.
Electro-Alloys Div., American Brake Shoe Co., Taylor St. & Abbe Rd., Elyria, Ohio
Electro Dynamic Div. of General Dynamics Corp., 163 Avenue A, Bayonne, N.J.
Elliott Co., 900 N. Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 N. MacQuesten Pkwy., Mt. Vernon, N.Y.
The Elreco Corp., 2000 Central Ave., Cincinnati 14, Ohio
Emglo Products Corp., 116 Dupont St., Johnstown, Pa.
The Ensign-Bickford Co., P.O. Box 308, Simsbury, Conn.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington, W. Va.
Enterprise Wheel & Car Corp., Bristol, Va.
Erico Products, Inc., 2070 E. 61 Pl., Cleveland 3, Ohio
Eriez Manufacturing Co., 228 Magnet Drive, Erie, Pa.
Esso Standard, Div. of Humble Oil and Refining Co., 15 West 51 St., New York, N.Y., ADV. p365
Euclid Div., General Motors Corp., Cleveland 17, Ohio

Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N.Y.

Exide Industrial Div., The Electric Storage Battery Co., Rising Sun and Adams Aves., Philadelphia 2, Pa., ADV. p375

Extremultus, Inc., 25-11 40th Ave., Long Island City 1, N.Y.

F

FWD Corp., E. 12th St., Clintonville, Wis.

The Fafnir Bearing Co., 37 Booth St., New Britain, Conn.

George E. Failing Co., Sub. of Westinghouse Air Brake Co., Enid, Okla.

The Fairbanks Co., 393 Lafayette St., New York 3, N.Y.

Fairbanks Morse & Co., 606 S. Michigan Ave., Chicago 5, Ill.

Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles 15, Calif.

Fairmont Machinery Co., Fairmont, W. Va., ADV. Second Cover

Fairview Bit Co., Fairview, W. Va., ADV. 352

The Falk Corp., Box 492, Milwaukee 1, Wis., ADV. 51

Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.

Farrell-Cheek Steel Co., 106 Lane St., Sandusky, Ohio, ADV. p378

Farris Flexible Valve Corp., 400 Commercial Ave., Palisades Park, N.J.

Farval Div., Eaton Mfg. Co., 3300 East 80th St., Cleveland 4, Ohio

The Federal Bearings Co. Inc., Poughkeepsie, N.Y.

Federal-Mogul Service, Div. Federal-Mogul — Bower Bearings, Inc., 11031 Shoemaker Ave., Detroit 13, Mich., ADV. p63, 369

Femco, Inc., Irwin, Pa., ADV. p35

Filter Fabrics, Inc., 814 E. Jefferson St., Goshen, Ind.

Filtration Engineers Div., American Machine & Metals Inc., East Moline, Ill.

Firestone Tire & Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio, ADV. p59

Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.

Fischer & Porter Co., 505 Warminster Rd., Warminster, Pa.

Fisher Scientific Co., 717 Forbes Ave., Pittsburgh 19, Pa.

J. H. Fletcher & Co., P.O. Box 2143 Huntington 18, W. Va.

Flexaust Co., 100 Park Ave., New York 17, N.Y.

Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.

Flexo Products, Inc., Westlake, Ohio

John Flocker & Co., 644 Grant St., Pittsburgh 19, Pa.

Flood City Brass & Electric Co., Messenger & Elder Sts., Johnstown, Pa., ADV. p90

The Fly Ash Arrestor Corp., P.O. Box 1883, Birmingham 1, Ala.

Flygt Corp., Hoosick Falls, N.Y.

Foote Brothers Gear & Machinery Corp., 4545 South Western Blvd., Chicago, Ill.

Foote Mineral Co., 18 W. Chelten Ave., Philadelphia 44, Pa.

Ford Div. of Ford Motor Co., P.O. Box 658, Dearborn, Mich.

Foster Wheeler Corp., 666 Fifth Ave., New York 19, N.Y.

Foxboro Co., Foxboro, Mass.

Fred's Welding Service, P.O. Box 178, Grundy, Va.

The Frick-Gallagher Mfg. Co., 110 S. Michigan Ave., Wellston, Ohio

Fuel Process Co. Inc., 900 D St., South Charleston, W. Va.

Fuel Research & Instrument Co., P.O. Box 19063, 1100 S. Arlington Ave., Indianapolis 3, Ind.

Fuller Mfg. Co., 1419 North Burdick St., Kalamazoo, Mich., ADV. p2-3

Fulton Cotton Mills, P.O. Box 1726, Atlanta 1, Ga.

The Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio

G

GM DIESEL, Detroit Diesel Engine Div., General Motors Corp., 13400 West Outer Drive, Detroit 28, Mich.

GMC Truck & Coach, General Motors Corp., Pontiac, Mich.

G & W Electric Specialty Co., 3500 W. 127 St., Blue Island, Ill.

The Galigher Co., 545-585 West 8th South St., P.O. Box 209, Salt Lake City 10, Utah

Galion Allsteel Body Co., 605 S. Market St., Galion, Ohio

Galion Iron Works & Mfg. Co. Galion, Ohio

Galis Electric & Machine Co., P. O. Box 2027 WO, Morgantown, W. Va.

Gardner-Denver Company, Quincy, Ill.

Garlock, Inc., 402 East Main St., Palmyra, N.Y.

Gar Wood Industries, Inc., Wayne, Mich.

The Gates Rubber Co., 999 South Broadway, Denver 17, Colo., ADV. p162

General Cable Corp., 730 Third Ave., New York 17, N.Y.

General Electric Co., Apparatus Sales Div., 1 River Road, Schenactady 5, N.Y.

General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept., 1 Campbell Rd., Rotterdam, N.Y.

General Electric Co., Communication Products Dept., Lynchburg, Va.

General Electric Co., Wire and Cable Dept., Conduit Products Dept., 1285 Boston Ave., Bridgeport, Conn.

General Electric Co., Lamp Div., Nela Park, Cleveland, Ohio

General Electric Co., Locomotive & Car Equipment Dept., 2901 E. Lake Rd., Erie 1, Pa.

General Equipment & Manufacturing Co., 116 S. Campbell St., Louisville 6, Ky.

General Logistics, 2929 Floyd St., Burbank, Calif.

General Scientific Equipment Co., Limekiln Pike & Williams Ave., Philadelphia 50, Pa.

General Splice Corp., 32 Woodworth Ave., Yonkers, N.Y.

The General Tire & Rubber Co., 1708 Englewood Ave., Akron, Ohio

Gensco Tools Div., General Steel Warehouse Co., Inc., 1830 N. Kostner Ave., Chicago 39, Ill.

The Geodimeter Co., 2013 Park Ave., South Plainfield, N.J.

Geo Optic & Paper Corp., 149 Church St., New York 7, N.Y.

Gering Plastics, Div. of Studebaker-Packard Corp., North 7th St. and Monroe Ave., Kenilworth, N.J.

Gibraltar Equipment & Mfg. Co., P.O. Box 304, Alton, Ill.

M. Glosser & Sons Inc., 80 Messenger St., Johnstown, Pa.

Goodall Rubber Co., Whitehead Rd., Trenton, N.J.

Goodman Mfg. Co., Halsted St. & 48th Place, Chicago 9, Ill., ADV. p73

B.F. Goodrich Aviation Products, 500 South Main St., Akron, Ohio

B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio

B. F. Goodrich Footwear and Flooring Co., a Div. of The B. F. Goodrich Co., Watertown 72, Mass.

B. F. Goodrich Industrial Products Co., 500 South Main St., Akron 18, Ohio, ADV. p1

B. F. Goodrich Tire Co., A Div. of the B. F. Goodrich Co., Arkon, Ohio, ADV. p145

Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio

The Gorman-Rupp Co., 305 Bowman St., Mansfield, Ohio, ADV. p377

Gould-National Batteries, Inc., Trenton 7, N.J.

Goulds Pumps, Inc., Seneca Falls, N.Y.

Goyne Pump Co., Ashland, Pa.

Gray Co., Inc., 56 Eleventh Ave., N. E., Minneapolis 13, Minn.

Grinnell Co., 260 West Exchange St., Providence 1, R.I.

Gruendler Crusher & Pulverizer Co., 2917 No. Market St., St. Louis 6, Mo.

Gulf Oil Corp., Dept. DM, P.O. Box 1166, Pittsburgh 30, Pa.

T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc., P.O. Box 283, Belleville, Ill., ADV. p167

Gurley, W. & L. E., 1904 Fifth Ave., Troy, N.Y.

Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.

Guyan Machy. Co., 755 Stratton, Logan, W. Va., ADV. p347

H

H & L Tooth Co., 1540 South Greenwood Ave., Montebello, Calif., ADV. p372

Hackbridge & Hewittic Electric Co., Ltd., P.O. Box 234, Pittsburg 30, Pa.

Hagan Chemicals & Controls, Inc., P.O. Box 1346, Pittsburgh 30, Pa.

Hammermills, Inc., 625 C. Ave., N. W., Cedar Rapids, Iowa

J. V. Hammond Co., Spangler, Pa.

F. R. Hannon & Sons, Canton 7, Ohio

Hardinge Co., Inc., 240 Arch St., York, Pa.

Harnischfeger Corp., 4444 W. National Ave., Milwaukee 46, Wis., ADV. p74-75

The Harrington & King Perforating Co., Inc., 5655 W. Fillmore St., Chicago 44, Ill.

Brad Harrison Co., 4222 Warren Ave., Hillside, Ill., ADV. p409

Hauck Mfg. Co., 144-154 Tenth St., Brooklyn 15, N.Y.

The Hauser-Stander Tank Co., 4838 Spring Grove Ave., Cincinnati 32, Ohio, ADV. p170

Herb J. Hawthorne, Inc., 8801 N. Main at 45th St., P.O. Box 7366, Houston 8, Tex.

Hays Corp., 742 E. 8th St., Michigan City, Ind.

The Heil Co., TEC Div., 1285 W. 70th St., Cleveland 2, Ohio

Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland 35, Ohio

Helicoid Gage Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.

Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.

Helwig Carbon Products, Inc., 2500 N. 30th St., Milwaukee 10, Wis.

Hendrick Mfg. Co., Carbondale, Pa., ADV. p109

Hendrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.

Hendrix Mfg. Co., P.O. Box 31, Mansfield, La.

Hercules Motors Corp., 101 11 St., S. E., Canton, Ohio

Hercules Powder Co., Delaware Trust Bldg., 900 Market St., Wilmington, Del., ADV. p360

Hercules Steel Products Co., Galion, Ohio

Herold Mfg. Co., 215 Hickory St., Scranton 5, Pa.

Hevi-Duty Electric Co., P.O. Box 563, Milwaukee 1, Wis.

Hewitt-Robins Incorporated, 666 Glenbrook Rd., Stamford, Conn., ADV. p150

The Hewson Co., Inc., 443 Broad St., Newark 2, N.J.

Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa., ADV. p16

Hobart Bros. Co., Hobart Square, Troy 1, Ohio

Hockensmith Corp., Penn, Pa.

Hodag Chemical Corp., 7247 North Central Park, Chicago 45, Ill.

Hoffman Brothers Drilling Co., Tiona and Ceder Sts., Punxsutawney, Pa.

Hoffman Combustion Engrg. Co., 1780 Southfield Rd., Lincoln Park, Mich.

Robert Holmes & Bros., Inc., 510 Junction Ave., Danville, Ill.

Holub Industries, Inc., 413 DeKalb Ave., Sycamore, Ill.

Homelite, a division of Textron, Inc., 75 Riverdale Ave. Port Chester, N.Y.

The Homer Mfg. Div., The Ohio Electric Mfg. Co., 142 E. Pearl St., Lima, Ohio

Homestead Valve Mfg. Co., Coraopolis, Pa.

Hose Accessories Co., 17th St. & Lehigh Ave., Philadelphia 32, Pa.

Hossfeld Mfg. Co., 460-462 W. Third St., Winnona, Minn., ADV. p352

The Frank G. Hough Co., 735 Seventh St., Libertyville, Ill.

Howe Scale Co., Rutland, Vt.

Howells Mining Drill Co., Plymouth, Pa.

Hoyt Wire Cloth Co., P.O. Box 1577, Lancaster, Pa.

Huber-Warco Co., Marion, Ohio, ADV. p166

Hughes Tool Co., 5425 Polk Ave., Houston, Tex.

Hulburt Oil & Grease Co., Trenton & Castor Ave., Philadelphia 34, Pa., ADV. p18-19

Hunt Valve Co., Div. of Internation Basic Economy Corp. (IBEC), 1913 E. State St., Salem, Ohio

Hyatt Bearings Div., General Motors Corp., Harrison, N.J.

Hydreco Div., The New York Air Brake Co., 9000 E. Michigan Ave., Kalamazoo, Mich.

Hyster Co., 2902 N.E. Clackamas St., Portland 8, Ore.

Hy-Test Safety Shoe Div., International Shoe Co., 1509 Washington Ave., St. Louis 66, Mo.

I

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.

Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.

Illinois Gear & Machine Co., 2108 N. Natchez Ave., Chicago 35, Ill.

Illinois Zinc Co., 2959 W. 47th St., Chicago 32, Ill.

Impact Rotor Tool, Inc., Route 30 East, Irwin, Pa., ADV. p393

Imperial-Cantrell Mfg. Co., P.O. Box 538, Jellico, Tenn.

Industrial Chemicals Div., Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo.

Industrial Engineering & Const. Co., Inc., First National Bank Bldg., Fairmont, W. Va.

Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus 14, Ohio

Industrial Physics & Electronics Co., 470 So. 10th East, Salt Lake City, Utah

Industrial Rubber Products Co., 815 Court St., Charleston, W. Va.

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp., Box 840, Lansing, Mich.

Infilco Inc., Gale Separator Div., P.O. Box 5033, Tucson, Ariz.

Ingersoll-Rand Co., 11 Broadway New York 4, N.Y., ADV. p155

Inland Steel Co., 30 W. Monroe St., Chicago 3, Ill.

Insley Mfg. Corp., 801 N. Olney St., Indianapolis 1, Ind.; General Offices — Indianapolis, Ind.; Western Regional Office: Alhambra, Calif.

International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., ADV. p70-71

International Harvester Co., Motor Truck Div., 180 N. Michigan Ave., Chicago 1, Ill., ADV. p69

International Nickel Co., Inc., 67 Wall St., New York 5, N.Y.

International Salt Co., Clarks Summit, Pa.

Interstate Equipment Corp., 433 N. Broad St., Elizabeth 3, N.J., ADV. p405

Iowa Mfg. Co., 916 16 St., N.E., Cedar Rapids, Iowa

The Ironton Engine Co., Farmingdale, N.J.

Irwin-Sensenich Corp., Box 311, Irwin, Pa.

Irvington Div. of Minnesota Mining & Mfg. Co., St. Paul, Minn.

J

Jeffrey Mfg. Co., 922 N. Fourth St., Columbus 16, Ohio, ADV. p358-359

Jenkins Bros., 100 Park Ave., New York 17, N.Y.

Johns-Manville, 22 East 40 St., New York 16, N.Y.
Johns-Manville Plastics Corp., 315 Grant St., Franklin, Pa.
The Johnson-March Corp., 3018 Market St., Philadelphia 4, Pa.
Johnson Plastic Corp., P.O. Box 100, Chagrin Falls, Ohio
G. R. Johnson Loading Supplies, 5026 Butterworth Rd., Mercer Island, Wash.
The R. G. Johnson Co., 25 S. College St., Washington, Pa.
Johnston Pump Co., Div. of The Youngstown Sheet and Tube Co., P.O. Bin K, Pasadena, Calif.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.
Joy Mfg. Co., 333 Oliver Bldg., Pittsburgh 22, Pa.; Coal Machy. Div. 3021 Banksville Rd., Pittsburgh 16, Pa.; 742 Eighth Ave., P.O. Box 1208, Huntington 14, W. Va.; 453 Main St., Luzerne, Pa.; 1203 Macklind Ave., St. Louis 10, Mo.; 1626 Waxee St., Denver 2, Colo., ADV. pp 169, 189, 190-191, 192, 175, 373
Joyce-Cridland Co., 2027 East 1st St., Dayton, Ohio
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.

K

K-W Dart Truck Co., 1301 N. Manchester Tfwy., Kansas City 20, Mo., ADV. p. 165
Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Dr., Oakland 12, Calif., ADV. p. 337, 338-339
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp., 300 Lakeside Dr., Oakland 12, Calif.
Kanawha Mfg. Co., Charleston 26, W. Va.
Keasbey & Mattison Co., Ambler, Pa.
Keenan Oil Co., Parkway Dr., Cincinnati 12, Ohio
Kelly Mfg. Co., Machine Parts Div., 503-505 Broad St., Charleston 21, W. Va.
Kenco Pump Div. of The American Crucible Products Co., 1305 Oberlin Ave., Lorain, Ohio
Kennametal, Inc., Mining Tool Div. Bedford, Pa., ADV. p. 180-181
Kennedy Valve Mfg. Co., Elmira, N.Y.
Kennedy Van Saun Mfg. & Eng. Corp., 405 Park Ave., New York 22, N.Y.
Kensington Steel, Div. of Poor & Co., 505 Kensington Ave., Chicago 28, Ill.
Kern Instruments Inc., 120 Grand St., White Plains, N.Y.
Kersey Manufacturing Co., Inc. P.O. Box 151, Bluefield, Va.
Keystone Carbon Co., 1935 State St., St. Marys, Pa.
Keystone Lubricating Co., 21 & Clearfield Sts., Philadelphia 32, Pa.
Walter Kidde & Co., Inc., 356 Main St., Belleville 9, N.J.
Kidde Ultrasonic & Detection Alarms, Inc., 356 Brighton Rd., Clifton, N.J.
S. P. Kinney Engineers, Inc., 201 Second Ave., Carnegie, Pa.
Kinney Vacuum Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.
Kirk & Cowin, Inc., 1 18th St., SW, Birmingham, Ala.
Koehring Div. of Koehring Co., 3026 W. Concordia Ave., Milwaukee 16, Wis.
Koppers Co. Inc., Metal Products Div., 200 Scott St., Baltimore 3, Md.
Koppers Co., Inc., Wood Preserving Div., 750-A Koppers Bldg., Pittsburgh 19, Pa.
Koven Fabricators, Inc., 90 E. Dickerson St., Dover, N.J.
Kremser & Sons, Inc., Frank A., P.O. Box 6207, Holmesburg Station, Philadelphia 36, Pa.
Kuhlman Elec. Co., 2565 E. Maple Rd., P.O. Box 2[illegible], Birmingham, Mich.

L

Laboratory Equipment Corp., Hilltop Rd., St. Joseph 3, Mich.
LaBour Co., Inc., 1607 Sterling Ave., Elkhart, Ind.
Laclede Stoker Co., 4444 Hunt Ave., St. Louis 10, Mo.
Ladish Co., 5481 S. Packard Ave., Cudahy, Wis.
Lancaster Pump & Mfg. Co., Inc., Lancaster, Pa.
Laubenstein Mfg. Co., Ashland, Pa.
Layne & Bowler, Inc., Box 6697, Hollywood Sta., Memphis 8, Tenn.
Layne & Bowler Pump Co., P.O. Box 6991, Los Angeles 22, Calif.
Lecco Machinery & Engineering Co., P.O. Box 1337, New Airport Rd., Bluefield, W. Va.
Ledeen, Inc., 3350 No. Gilman Rd., El Monte, Calif.
Lee-Norse Co., Charleroi, Pa., ADV. p 147
The Leetonia Tool Co., 142 Main St., Leetonia, Ohio
Leman Machine Co., S. Railroad St., Portage, Pa., ADV. p 158
Le Roi Div., Westinghouse Air Brake Co., Milwaukee 1, Wis., ADV. p 43
Leschen Wire Rope Div., H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo.
R. G. LeTourneau Inc., 2395 S. MacArthur, Longview, Texas
LeTourneau - Westinghouse Co., 2301 N.E. Adams St., Peoria, Ill.
Linatex Corp. of America, Drawer "D" Stafford Springs, Conn., ADV. p 171
Linco Co., 762 S. Main St., Greensburg, Pa.
The Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co., 5701 Natural Bridge Ave., St. Louis, Mo., ADV. p 24-25
Link-Belt Co., Dept CAMGL-60 Prudential Plaza, Chicago 1, Ill., ADV. Fourth Cover
Link-Belt Speeder Corp., Cedar Rapids, Iowa
Lippmann Engineering Works Inc., 4603 West Mitchell St., Milwaukee 14, Wis.
Herbert S. Littlewood, R.D. 3, Irwin, Pa.
Peter F. Loftus Corp., First National Bank Bldg., Pittsburgh 22, Pa.
Logan Gear Co., Inc., Box 831, Logan, W. Va.
Long-Airdox Co., Div. of Marmon-Herrington Co., Inc., P.O. Box 331, Oak Hill, W. Va., Chicago, Ill.
Lubriplate Div., Fiske Brothers Refining Co., 129 Lockwood St., Newark 5, N.J.
Ludlow Saylor Wire Cloth Co., 634 South Newstead, St. Louis 10, Mo., ADV. p 64
Ludlow Valve Mfg. Co., Inc., P. O. Box 388, Troy 1, N.Y.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lukens Steel Co., 376 Services Bldg., Coatesville, Pa.
The Lunkenheimer Co., Beekman St. and Waverly Ave., Cincinnati 14, Ohio

M

Machinery Center, Inc., 1201 S. Sixth West, P.O. Box 964, Salt Lake City, Utah
Mack Trucks, Inc., 1355 West St., Plainfield, N.J., ADV. p 94-95
Macwhyte Wire Rope Co. 2931 14th Ave., Kenosha, Wis., ADV. p 27
Magic Chemical Co., 121 Crescent St., Brockton 2, Mass.
Magnetic Engrg. & Mfg. Co., 851 Van Houten Ave., Clifton, N.J.
Maintenance Engineering Corp., P.O. Box 10426, Pittsburgh 34, Pa., ADV. p 405
Majac, Inc., Sub. of Blackstone Corp., 23rd St., Sharpsburg, Pittsburgh 15, Pa.
Mancha Storage Battery Locomotive, div. Goodman Mfg. Co., Halsted St., & 48th Pl., Chicago 9, Ill.
Manheim Mfg. & Belting Co., 470 Stiegel St., Manheim, Pa.
Manitowoc Engineering Corp., S. 16th St., Manitowoc, Wis.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. Muskegon, Mich.
Manzel Div., Houdaille Industries, Inc., 315 Babcock St., Buffalo 10, N.Y.
Marathon Coal Bit Co., Inc., Box 391, Montgomery, W. Va.
Marietta Concrete Div., American-Marietta Co., Box 669, Marietta, Ohio
Marietta Manufacturing Co., P.O. Box 17, Point Pleasant, W. Va.
Marion Handle Mills, Inc., Marion, Va.
Marion Metal Products, Co. Chaney Ave., Marion, Ohio
Marion Power Shovel Co., a div. of Universal Marion Corp., Marion, Ohio, ADV. p 62
Marland One-Way Clutch Co., Elm Ave. & Washington St., La Grange, Ill.
Marlin-Rockwell Corp., 402 Chandler St., Jamestown, N.Y., ADV. p. 164
Marlow Pumps, Div. of Bell & Gossett Co., Box 200, Midland Park, N.J.
Marman Div., Aeroquip Corp., 11214 Exposition Blvd., Los Angeles 64, Calif.
E. F. Marsh Engrg. Co., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martin Engrg. Co., Cab Road, Neponset, Ill.
Martindale Electric Co., 1307 Hird Ave., Cleveland 7, Ohio
Master Bronze Powder Co., Inc., 538-548 W. State St., Calumet City, Ill.
The Master Electric Co., Div. of Reliance Electric & Engrg. Co., 126 Davis Ave., Dayton 1, Ohio
Mayo Tunnel & Mine Equipment, Lancaster, Pa.
McDowell Co., Inc., 113 St. Clair Ave., N.E., Cleveland 14, Ohio
McDowell Mfg. Co., 301 Stanton Ave., Pittsburgh 9, Pa.
The McKay Co., 1005 Liberty Ave., Pittsburgh 22, Pa.; Plant — Grantley Rd., York, Pa.
McLanahan & Stone Corp., Hollidaysburg, Pa., ADV. p 159
McLaughlin Mfg. Co., Inc., 801 E. Cass St., Joliet, Ill.
McNally-Pittsburg Mfg. Corp., 307 West Third St., Pittsburg, Kan., ADV. p 148
Meckum Engineering, Inc., 53 W. Jackson Blvd., Chicago 4, Ill.
Megator Corp., 930 Manchester Ave., Pittsburgh 12, Pa.
Meissner Engineers, Inc., 300 W. Washington St., Chicago 6, Ill.
Merrick Scale Mfg. Co., 184 Autumn St., Passaic, N. J. ADV. p 186
Metal Carbides Corp., 6001 Southern Blvd., Youngstown 12, Ohio, ADV. p 186
Metal & Thermit Corp., Rahway, N. J.
Metallurgical Products Dept., General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich., ADV. p 60, 61
Midland Pipe & Supply Co., 2829 S. 61st Ct., Chicago 50, Ill.
Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa., ADV. p 176-177
Mine and Smelter Supply Co., Manufacturing Div., P. O. Box 9401 (3800 Race St.), Denver, Colo., ADV. p 170
Mine Ventilation Systems, Inc., Box 382, Madison, W. Va.
Miners Hardware Supply Co., 215 Martin Bldg. Pittsburgh 12, Pa., ADV. p 392
Mining Machine Parts Inc., 13700 Broadway Ave., Cleveland 25, Ohio
Mining Progress, Inc., P. O. Box 3, Highland Mills, N. Y.
Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Ave., Phila. 44, Pa.
Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.
Mitchell Industrial Tire, Inc., Box 468, Chattanooga, Tenn.
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc., 150 E. 42nd St., New York 17, N. Y.
Mobile Aerial Towers, Inc., 1730 N. Harrison St., Fort Wayne, Ind.
Mobile Drilling, Inc., 960 North Pennsylvania St., Indianapolis, 4, Ind.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
Monsanto Chemical Co., 800 N. Lindbergh Blvd., St. Louis 66, Mo.
The Moore Co., 1036 Quarrier St., Charleston, W. Va.
Morris Machine Works, Baldwinsville, N. Y.
Morse Bros. Machinery Co., 2900 Brighton Blvd., Denver 1, Colo.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.
Morton Salt Co., 110 No. Wacker Dr., Chicago 6, Ill.
Mosebach Electric & Supply Co., 1115 Arlington Ave., Pittsburgh 3, Pa.
T. J. Moss Tie Co., 700 Security Bldg., St. Louis 2, Mo.
Motor Exchange and Supply Co., Hines, W. Va.
Motorola Communications & Electronics, Inc., 4501 West Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington 17, W. Va.
Murphy Diesel Co., 5317 West Burnham St., Milwaukee, Wis.
Myers-Whaley Co., P. O. Box 789, Knoxville 1, Tenn.

N

Nachod & U. S. Signal Co., 4777 Louisville Ave., Louisville 9, Ky., ADV. p 384
Nagle Pumps, Inc., 1237 Center Ave., Chicago Heights, Ill.
Nash Engineering Co., South Norwalk, Conn.
Nathan Mfg. Div., Wegner Machinery Corp., 35-41 11th St., Long Island City 6, N. Y.
National Air Vibrator Co., 435 Literary Rd., Cleveland 13, Ohio
National Carbon Co., Division of Union Carbide Corp., 270 Park Ave., New York 17, N. Y.
National Electric Coil, Div. of McGraw-Edison Co., 800 King Ave., Columbus 16, Ohio
National Electric Products Co., Gateway Center, Bldg. 2, 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.
National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland 6, Ohio, ADV. p 29
National Mine Service Co., 2530 Koppers Bldg., Pittsburgh 19, Pa.; Alabama Div., Birmingham, Ala.; Clarkson Div., Nashville, Ill.; Bemeco Div., Beckley W. Va.; All-State Div., Logan, W. Va.; Kentucky-Virginia Div., Jenkins, Ky.; Whiteman Div., Indiana, Pa.; Ashland Div., Ashland, Ky.; Anthracite Div., Forty Fort, Pa.; Western Kentucky Div., Madisonville, Ky.; Greensburg Div., Greensburg, Pa.; Mountaineer Div., Morgantown, W. Va.; National Mine Service (Canada) Ltd., Elliot Lake, Ontario, ADV. pp 45, 76
National Powder Co., Eldred, Pa.
National Supply Company, 2 Gateway Center, Pittsburgh, Pa.
National Tube Div., United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa., ADV. p. 125
Naylor Pipe Co., 1262 E. 92 St. Chicago 19, Ill.
The Neff & Fry Co., 320 Elm St., Camden, Ohio
Newark Wire Cloth Co., 351 Verona Ave., Newark 4, N. J.
Newcomer Products, Inc., Latrobe, Pa.
New Departure Div., General Motors Corp., 269 N. Main St., Bristol, Conn.
New Jersey Meter Co., Inc., 350 Leland Ave., Plainfield, N. J.
New York Central System, 466 Lexington Ave., New York, N. Y.
New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.
New York Rubber Co., 100 Park Ave., New York 17, N. Y.
The Nolan Co., Bowerston, Ohio, ADV. p 366
Nordberg Mfg. Co., 3073 South Chase Ave., Milwaukee 1, Wis.

Norma-Hoffman Bearings Corp., Stamford, Conn.
North American Gear Co., Box 7, Blairsville, Pa., ADV. p392
Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.
NoVo Div., Industrial Enterprises Inc., 9705 Cottage Grove Ave., Chicago 28, Ill.

O

Ohio Brass Co., Mansfield, Ohio, ADV. p141, 152
Ohio Carbon Co., 12508 Berea Road, Cleveland 11, Ohio
Ohio Oil Co., Findlay, Ohio
Okonite Co., Canal St., Passaic, N. J.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div., East Alton, Ill.
The Oliver Corp., 400 West Madison St., Chicago 6, Ill.
Onox, Inc., 121 Second St., San Francisco 5, Calif.
Kurt Orban Co., Inc., Industrial Equipment Div., 22 W. Putnam Ave., Greenwich, Conn.
The Ore & Chemical Corp., 80 Broad St., New York 4, N. Y.
Ore Reclamation Co., 301 No. Connell Ave., Picher, Okla.
Orefraction, Inc., 7425 Thomas St., Pittsburgh 8, Pa.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.

P

PLM Products Inc., 3871 W. 150th St., Cleveland 11, Ohio, ADV. p353
Page Engineering Co., Clearing Post Office, Chicago 38, Ill.
Page Steel & Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.
The Palnut Co., Div. of United-Carr Fastener Corp., Mountainside, N. J.
Paltech Co., Thayer Pond Rd., New Canaan, Conn.
Pangborn Corp., 2800 Pangborn Blvd., Hagerstown, Md.
Paris Mfg. Co., Paris, Ill.
Parker Fittings & Hose Div. and Parker Hydraulics Div., 17325 Euclid Ave., Cleveland 12, Ohio
The Parkersburg Rig & Reel Co., Div. of Parkersburg-Aetna Corp., 1958 Crawford St., Parkersburg, W. Va.
Pattin Manufacturing Co., Marietta, Ohio
Peerless Photo Products, Inc., Shoreham, N. Y.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp., 301 West Ave. 26, Los Angeles 31, Calif.
Penn Machine Co., 106 Station St., Johnstown, Pa.
Pennsylvania Crusher Div., Bath Iron Works Corp., Room 1711, West Chester, Pa., ADV. p56
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.; Masonry Drill Div., 1201 Banksville Rd., Pittsburgh 16, Pa.
Pennsylvania Electric Coil Corp., 1301 Saw Mill Run Blvd., Pittsburgh 26, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Pennsylvania Refining Co., Butler, Pa.
Perfection Steel Body Co., East St., Galion, Ohio
Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.
Peterson Filters & Engineering Co., 1949 S. Second West, P. O. Box 606, Salt Lake City 10, Utah
Pettibone Mulliken Corp., Haiss Div., 1212 E. Dominick St., Rome N. Y.
J. B. Pfister Co., 662 Ohio St., Terre Haute, Ind.
Phelps Dodge Copper Products Co., 300 Park Ave., New York 22, N. Y., ADV. p149
Phoenix Steel Corp., Structural & Tube Divisions, Phoenixville, Pa.; Plate Div., Harrisburg, Pa.; Phoenix Bridge Co., Phoenixville, Pa.
Phoenix Products Co., Inc., 4737 North 27th St., Milwaukee 9, Wis.
Pierce Management Corp., P. P. & L. Bldg., Scranton 3, Pa., ADV. p347
Pioneer Engineering, Div. of Poor & Co., 3200 Como Ave., Minneapolis 14, Minn.
Pipe Linings, Inc., P. O. Box 457, Wilmington, Calif.
Pitman Manufacturing Co., Garner Ave. & Duck Rd., Grandview, Mo.
Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Gear Co., Neville Island, Pittsburgh 25, Pa.
Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.
Plymouth Locomotive Works, Div. of the Fate-Root-Heath Co., Plymouth, Ohio
Plymouth Rubber Co., Inc., 51 Revere St., Canton, Mass.
H. K. Porter Co., Connors Steel Div., West Virginia Works, P.O. Box 118, Huntington, W. Va.; Connors Works, P. O. Box 2562, Birmingham, Ala., ADV. p14-15
H. K. Porter Co., Inc., National Electric Div., Porter Bldg., Pittsburgh 19, Pa.
H. K. Porter, Inc. 74 Foley St., Somerville, Mass.
Porto Pump, Inc. 19735 Ralston, Detroit 3, Mich.
The Post-Glover Electric Co., P.O. Box 709, Covington, Ky.; Plant-Kenton Lands Rd., Erlanger, Ky., ADV. p34
Preco Incorporated, 6300 E. Slauson Ave., Los Angeles 22, Calif.
Prime Mover Co., Muscatine, Iowa
K. Prins & Associates, Wellston, Ohio
Productive Equipment Corp., 2926 West Lake St., Chicago 12, Ill.
Propellex Chemical Div., Chromoloy Corp., P. O. Box 187, Edwardsville, Ill., ADV. p385
Proto Tool Co., Div. of Pendleton Tool Industries, Inc., 2209 Santa Fe Ave., Los Angeles, Calif.
Frank Prox Company, Inc., 1201 South First St., Terre Haute, Ind.
Pulmosan Safety Equip. Co., 644 Pacific St., Brooklyn, N. Y.
Pure Carbon Co., Inc., 441 Hall Ave., St. Marys, Pa.
The Pure Oil Co., 620 E. Broad St., Columbus, Ohio

Q

"Quick-Way" Truck Shovel Co., 2401 E. 40th Ave., Denver, Colo.

R

R-P & C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.
Raybestos Manhattan, Inc., Manhattan Rubber Div., 42 Townsend St., Passaic, N. J.
Read, Davis, Consulting Engineer, 1020 Adams St., Sturgis, Ky.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reeves Pulley Co. Div., Reliance Electric & Engineering Co., 1225 7th St., Columbus, Ind.
RELCHdrill Div., Chicago Pneumatic Tool Co., 1442 Beech St., Terre Haute, Ind.
Reid Belt & Rubber Co., Inc., 917 Grant St., Bluefield, W. Va.
Geo. P. Reintjes Co., P. O. Box 856, Kansas City 41, Mo.
Reliance Elec. & Eng. Co., 24701 Euclid Ave., Cleveland 17, Ohio
Reliance Insurance Co., 401 Walnut St., Philadelphia 6, Pa.
Remaly Mfg. Co., Inc., Tamaqua, Pa.
Rema-Tech, Inc., 2 Park Ave., New York 16, N.Y. ADV. p344
Remington Arms Co., Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Reo Div., The White Motor Co., 1331 South Washington St., Lansing 20, Mich.
Republic Creosoting Co., 1615 Merchants Bank Bldg., Indianapolis 4, Ind.
Republic Rubber Div., Lee Rubber & Tire Co., Youngstown 1, Ohio
Republic Steel, Republic Bldg., Cleveland 1, Ohio
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N. Y.
Revere Corp. of America, Sub. of Neptune Meter Co., Wallingford, Conn.
Rexarc, Inc., Rexarc Pl., West Alexandria, Ohio
Reynolds Metals Co., P. O. Box 2346ZH, Richmond 18, Va.
Rice Pump & Machine Co., 600 Park St., Belgium, Wis.
The Ridge Tool Co., 400 Clark St., Elyria, Ohio
Riegel Textile Corp., 260 Madison Ave., New York, N. Y.; Glove Div., Conover, N. C.
Robbins Machine & Mfg. Co., P. Box 281, Oneonta, Ala.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Roberts & Schaefer Company, Division Thompson-Starrett Company, Inc., 201 N. Wells St., Chicago 6, Ill., ADV. p6
Robinson & Robinson, Inc., Union Bldg., Charleston, W. Va.
Robinson Ventilating Co., 280 Henderson St., Zelienople, Pa.
Rochester Ropes Inc., Culpeper, Va.
Rockbestos Wire & Cable Co., Div. of Cerro de Pasco Corp., Nicoll and Canner Sts., New Haven 4, Conn.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
Rockwell-Stanford Corp., Brake Div., Ashtabula, Ohio
Rockwell-Standard Corp., Transmission and Axle Div., Detroit 32, Mich.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp., 640 South Broad St., Trenton 2, N. J., ADV. p357
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N. Y.
Rome Cable Div. of Alcoa, 424 Ridge St., Rome, N. Y., ADV. p380-381
Roots-Connersville Blower Div., Dresser Industries, Inc., 900 W. Mount St., Connersville, Ind.
Ross Screen & Feeder Co., 100 Quimby St., Westfield, N. J.
The Ruberoid Co., 500 Fifth Ave., New York 36, N. Y.
Ruger Equipment, Inc., 615 W. 4th St., Uhrichsville, Ohio
Rust-Oleum Corp., 2425 Oakton St., Evanston, Ill.
Rydin Railway Equip. Co., 224 S. Michigan Ave., Chicago 4, Ill.
Joseph T. Ryerson & Son, Inc., P. O. Box 8000A, Chicago 80, Ill.

S

SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa.
Salem-Brosius, Inc., P. O. Box 2222, Pittsburgh 30, Pa.
The Salem Tool Co., 767 S. Ellsworth Ave., Salem, Ohio, ADV. p22-23
Sanford Day Iron Works, Inc., P. O. Box 1511, Knoxville 9, Tenn. ADV. p388-389
Sauerman Bros., Inc., 620 South 28th Ave., Bellwood, Ill.
W. J. Savage Co., 912 Clinch Ave., S.W. Knoxville 16, Tenn.
Scandura, Inc., 112 Keswick Ave., P. O. Box 949, Charlotte 1, N. C.
Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh 22, Pa.
Schield Bantam Co., 221 Park St., Waverly, Iowa
Schramm Inc., 871 E. Virginia Ave., West Chester, Pa.
Schroeder Bros. Corp., Nichol Ave., Box 72, McKees Rocks Pa., ADV. p367
Scientific & Process Instruments Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.
Scranton Electric Construction Co., P. O. Box 1250, Scranton, Pa.; Branch—382 S. Center St., Pottsville, Pa.
Screen Equipment Co., Inc., Buffalo 25, N. Y.
Screw and Bolt Corp. of America, P. O. Box 1708, Pittsburgh 30, Pa.
Security Engrg. Div., Dresser Industries, Inc., 3400 W. Illinois, Dallas, Texas, ADV. p397
Seiberling Rubber Co., Akron 9, Ohio
Shaft and Development Machine Co., 808 Newhouse Bldg., Salt Lake City 11, Utah
Sheffield Div., Armco Steel Corp., Sheffield Sta., Kansas City, Mo.
Shell Oil Co., 50 W. 50th St., New York, N. Y., ADV, p349
Shepard Niles Crane & Hoist Corp., Schuyler Ave., Montour Falls, N. Y.
R. H. Sheppard Co., Inc., Hanover, Pa.
Shirley Machine Co., 725 Liberty Ave., Pittsburgh 22, Pa.
Sika Chemical Corp., 35 Gregory Ave., Passaic, N.J.
Silver Engineering Works, Inc., 3309 Blake St., Denver 5, Colo.
Simonds Saw & Steel Co., 470 Main St., Fitchburg, Mass.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Simplicity Engineering Co., Durand, Mich.
Sinclair Refining Co., 600 Fifth Ave., New York 20, N. Y.
J. K. Smit & Sons, Inc., Murray Hill, N. J.
Smith Tool Co., Box 431, Compton, Calif.
Smith Engineering Works, 502 East Capitol Dr., Milwaukee, Wis.
F. S. Smithers & Co., 1 Wall St., New York 5, N. Y.
Snap-On Tools Corp., 8132 28 Ave., Kenosha, Wis.
The Snow-Nabstedt Gear Corp., 251 Welton St., Hamden 7, Conn.
South Bend Div., Curtiss-Wright Corp., South Bend, Ind., ADV. p53
South Bend Lathe, Inc., 425 E. Madison St., South Bend 22, Ind.
Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles 58, Calif.
Spang & Company, P. O. Box 751, Butler, Pa.
Sprague & Henwood Inc., 221 W. Olive St., Scranton, Pa.
Spraying Systems Co., Randolph St., Bellwood, Ill.
W. F. Sprengnether Instrument Co., Inc., 4576 Swan Ave., St. Louis 10, Mo.
Sprout Waldron & Co., Inc., Muncy, Pa.
Stackpole Carbon Co., Stackpole St., St. Marys, Pa.
W. R. Stamler Corp., Paris, Ky., ADV. p168
Standard Carbon Co., P. O. 49, Steubenville, Ohio
Standard Devices Co., 3231 Warrensville Center, Cleveland 22, Ohio
Standard Oil Co. (Ind.). 910 South Michigan Ave., Chicago 80, Ill.
Standard Steel Corp., 5001 S., Boyle Ave., Los Angeles 58, Calif.
Star Hydraulics, Inc., 420 Lexington Ave., New York 17, N. Y.
Stearns Magnetic Products, div. of Indiana General Corp., 635 So. 28th St., Milwaukee 46, Wis.
The Stearns-Roger Mfg. Co., 660 Bannock St., P. O. Box 5888, Denver 17, Colo.
Stedman Foundry & Machine Co., Inc., Aurora, Ind.
Steel-Bilt Construction Co., P. O. Box 309, Bridgeville, Pa.
Steelcraft Mfg. Co., 9017 Blue Ash Rd., Cincinnati 42, Ohio
Stephens-Adamson Mfg. Co., 230 Ridgeway Ave., Aurora, Ill.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
Sterling Steel Casting Co., P. O. Box 230, East St. Louis, Ill.
Stewart-Warner Corp., Alemite Div., 1826 Diversey Pkway., Chicago 14, Ill.

Stonhard Co. Inc., 401 N. Broad St., Philadelphia 8, Pa.
Stoody Co., 11928 East Slauson Ave., Whittier, Calif.
Straub Mfg. Co., Inc., 8383 Baldwin St., Oakland 21, Calif.
Stulz-Sickles Co., 929-39 Julia St., Elizabeth, N. J.
Sturtevant Mill Co., 103 Clayton St., Dorchester, Boston 22, Mass.
Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa., ADV. p356
Superior Carbon Products, Inc., 9115 George Ave., Cleveland 5, Ohio
Peter O. Sutphen Co., P. O. Box 58, Everett, Pa.
Swan-Finch Petrochemicals, 5849 W. 66th St., Chicago, Ill.
Syntron Co., 975 Lexington Ave., Homer City, Pa.

T

Talcott, Inc., 91 Sabin St., Providence 1, R. I.
Talk-A-Phone Co., 5013 No. Kedzie Ave., Chicago 25, Ill.
Tamping Bag Co. Div., Pickard Industries, Inc., Mt. Vernon, Ill.
Taylor-Wharton Co. Div., Harsco Corp., High Bridge, N. J.
Templeton, Kenly & Co., 16th & Gardner Rd., Broadview, Ill., ADV. p52
Templeton-Matthews Corp., 905 Sycamore Bldg., Terre Haute, Ind.
Texaco Inc., 135 East 42nd St., New York 17, N.Y. p91
Thermex Metallurgical, Inc., Lakehurst, N. J. ADV. p403
Thermoid Div., H. K. Porter Co., Inc., Tacony & Comly Sts., Philadelphia 24, Pa., ADV p153
The Thew Shovel Co., Lorain, Ohio
Thomas Engineering & Construction Co., Box 646, Greensburg, Pa.
Thomas Flexible Coupling Co., Main Ave. and Biddle St., Warren, Pa.
Thompson Products Valve Div., Thompson Ramo Wooldridge Inc., 1455 E. 185th St., Cleveland 10, Ohio
Thor Power Tool Co., 175 N. State St., Aurora, Ill.
Thurman Scale Co., Div. Thurman Mfg. Co., 1939 Refugee Rd., Columbus, Ohio
Tidewater Oil Co., 17 Battery Pl., New York 4, N. Y.
The Timken Roller Bearing Co., 1835 Dueber Ave., S.W., Canton 6, Ohio
Toledo Pipe Threading Machine Co., P. O. Box 1678, Toledo 3, Ohio
The Tool Steel Gear & Pinion Co., 211 Township Ave., Cincinnati 16, Ohio
Torrington Co., 59 Field St., Torrington, Conn.
Trabon Engineering Corp., 28815 Aurora Rd., Solon 39, Ohio
Bertrand P. Tracy Co., 919 Fulton St., Pittsburgh 33, Pa.
Transail, Incorporated, P. O. Box 1588, 109 North 11 St., Birmingham 4, Ala.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Triangle Conduit & Cable Co., Inc., Box 711, Triangle & Jersey Aves., New Brunswick, N. J.
Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12, Wis.
Tube Turns, Div. of Chemetron Corp., 224 E. Broadway, Louisville 1, Ky.
Tulsa Winch, Div. of Vickers Incorporated, 815 East First St., Tulsa 20, Okla.
Tweco Products, Inc., 1450 South Mosley, Wichita 1, Kan.
Twin Disc Clutch Co., Racine Wis.; Hydraulic Div. and Export Div., Rockford, Ill.
W. S. Tyler Co., 3615 Superior Ave., Cleveland 14, Ohio, ADV. pThird Cover
Tyson Bearing Co., Div. of S-K-F Industries, Inc., Massillon, Ohio

U

Union Switch & Signal Div. of Westinghouse Air Brake Co., Pittsburgh 18, Pa., ADV. p135
Union Wire Rope Corp., Sub. of Armco Steel Corp., 2130 Manchester Ave., Kansas City 26, Mo., ADV. p92-93
Unit Crane & Shovel Corp., 6411 West Burnham St., Milwaukee 19, Wis.
U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles 54, Calif.
United States Pipe & Foundry Co., 3300 First Ave., N., Birmingham 2, Ala.
United States Rubber Co., 1230 Ave. of the Americas, New York 20, N. Y., ADV. p10, 66-67
United States Safety Service Co., 1535 Walnut St., Kansas City 8, Mo.
United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa., ADV. p130-131
Universal Road Machinery Co., Kingston, N. Y.
Universal Vibrating Screen Co., Deane Blvd. & St. Paul R.R., Racine, Wis.
The Upson-Walton Co., 12515 Elmwood Ave., Cleveland 11, Ohio
Utility Mine Equipment Co., 1010 Collingwood Rd., St. Louis 32, Mo.

V

Valvoline Oil Co., Div. of Ashland Oil & Refining Co., 639 Third Ave., Freedom, Pa.
R. T. Vanderbilt Co., Inc., 230 Park Ave., New York, N. Y.
Varel Mfg. Co., Inc., 9230 Denton Dr., P. O. Box 13146, Dallas 20, Texas
Vascoloy-Ramet Corp., 800 Market St., Waukegan, Ill., ADV. p355
Viber Co., 726 S. Flower St., Burbank, Calif.
Vibration Measurement Engineers, 725 Oakton Ave., Evanston, Ill.
Vickers Incorporated, Administrative & Engineering Center, Detroit 32, Mich.
Victaulic Co. of America, Box 509, Elizabeth, N. J., ADV. p346
Visking Co., Plastics Div., 6733 W. 65th St., Chicago 38, Ill.
Vulcan Iron Works, Inc., 730 South Main St., Wilkes Barre, Pa.
Vulcan Iron Works Co., 2961 South Fox St., Englewood (Denver), Colo.

W

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 33, Mo.
Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.
Walworth Co., 750 Third Ave., New York 17, N. Y.
Warminster Fiberglass Co., Warminster, Pa.
Warner Laboratories, Inc., Cresson, Pa.
Warren Refining & Chemical Co., 5151 Denison Ave., Cleveland 2, Ohio
Watt Car & Wheel Co., Barnesville, Ohio
Waukesha Motor Co., West St. Paul Ave., Waukesha, Wis.
Weatherhead Co., Fort Wayne Div., 128 Washington St., Fort Wayne, Ind.
Webster Mfg., Inc., West Hall St., Tiffin, Ohio
Wedge Wire Corp., Gas St. & N.P.R.R., Wellington, Ohio
Paul Weir Co., Inc., 20 N. Wacker Drive, Chicago 6, Ill.
S. K. Wellman Co., 200 Egbert Rd., Bedford, Ohio
WEMCO Div., Western Machinery Co., 650 Fifth St., San Francisco, 7, Calif., ADV. p156
West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
West Virginia Armature Co., Bluefield, W. Va.
West Virginia Belt Repairs, Inc., P. O. Box 32, Mount Hope, W. Va.
Western Insulated Wire Co., 2425 East 30 St., Los Angeles 58, Calif.
Western Precipitation Div., Joy Mfg. Co., 1000 West Ninth St., Los Angeles 54, Calif.
Westinghouse Electric Corp., 3 Gateway Center, P. O. Box 2278, Pittsburgh 30, Pa., ADV. p182-183
Westinghouse Electric Corp., Sturtevant Div., Hyde Park 36, Mass.
Wheelabrator Corp., 1476 S. Byrkit St., Mishawaka, Ind.
Wheeler Electronic Corp., Sub. of Sperry Rand Corp., 150 East Aurora St., Waterbury, Conn.
White Diesel Engine Div., The White Motor Co., Springfield, Ohio
The Whitmore Mfg. Co., P. O. Box 1640, Station C, Cleveland 4, Ohio
Whiting Corp., Harvey, Ill.
The Whitney Chain Co., a sub of Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.
Wichita Clutch Co., Inc., Wichita Falls, Texas
The Wilbur & Williams Co., Inc., 650 Pleasant St., Norwood, Mass.
Wilcox Mfg. Co., P. O. Box 217, Raleigh, W. Va.
Wild Heerbrugg Instruments, Inc., Main & Covert Sts., Port Washington, N. Y., ADV. p50
Wiley Mfg. Co., Port Deposit, Md.
A. R. Wilfley & Sons, P. O. Box 2330, Denver 1, Colo., ADV. p351
Williams Patent Crusher & Pulv. Co., 810 Montgomery St., St. Louis 6, Mo.
Wilmot Engineering Co., 8 West Broad St., Hazleton, Pa.
L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., 303 Vreeland Mills Rd., Linden, N. J.
Winslow Government Standard Scale Works, Inc., 4805 Lafayette St., Terre Haute, Ind.
Winter-Weiss Co., 2201 Blake St., Denver 5, Colo.
Wire Rope Corp. of America, Inc., 609 North Second St., St. Joseph, Mo.
Wisconsin Motor Corp., Milwaukee 46, Wis.
Wise Co., Inc., O. B., P. O. Box 42, 2519 Cherry Arcade, Knoxville 1, Tenn.
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T. B. Woods Sons Co., Chambersburg, Pa.
J. W. Woomer & Associates, 821 Oliver Bldg., Pittsburgh 22, Pa.
Worthington Corp., 421 Worthington Ave., Harrison, N. J.
Wright Power Saw & Tool Corp., Div. of Thomas Industries, Inc., 1419 Illinois Ave., Sheboygan, Wis.
Wyandotte Chemicals Corp., Michigan Alkali Div., Wyandotte, Mich.
Wyssmont Co., Inc., 42-07B 27th St., Long Island City 1, N.Y.

Y

Yale & Towne Mfg. Co., 11000 Roosevelt Blvd., Philadelphia 15, Pa.
Yardley Plastics Co., 142 Parsons Ave., Columbus 15, Ohio
Yardney Electric Corp., 40 Leonard St., New York 13, N. Y.
The Youngstown Sheet and Tube Co., Youngstown 1, Ohio

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A

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Mobile: Allied Auto Parts, 265 St. Louis St.
Montgomery: Dixie Trailer & Brake Service, 1961 Bell St.
ILLINOIS, Chicago 7: Chicago Tire & Rubber Co., 850 Washington Blvd.
Decatur: Midstate Machinery Co., 359 E. Main St.
E. St. Louis: Illinois Electric Works, Inc., 1300-10 Missouri Ave.
INDIANA, Evansville 7: Hocker Power Brake Co., 3rd & Ingle at Carpenter
KENTUCKY, Ashland: National Mine Service Co., Ashland Plant, P. O. Box 888
Jenkins: National Mine Service Co., Kentucky-Virginia Div., P. O. Box 872
Madisonville: National Mine Service Co., Western Kentucky Div., 132 East Center St.
PENNSYLVANIA, Harrisburg: Safety Sales & Service Corp., P. O. Box 1129
Indiana: National Mine Service Co., Whiteman Div., 1260 Maple St.
Pittsburgh 6: The Cypher Co., 1201 Washington Blvd.
Pittsburgh 3: Transmission Equip. Co., 1200 Muriel St.
VIRGINIA, Portsmouth: Morse-Parker Motor Supply Co., P. O. Box 587
Norfolk: Diesel Injection Sales & Service Inc., 808 Union. Tidewater Supply Co., 501 W. 24th St.
Richmond: Cummins Diesel Sales & Service, P. O. Box 9426 Standard Parts Corp., 500 E. 9th Rd.
Roanoke: Standard Parts Corp., 4117 Williamson Rd. Tidewater Supply Co.
Salem: Diesel Injection Sales & Service, Inc., 1016 Delaware St.
Winchester: Valley Distributors Inc., 22 Amherst St.
WEST VIRGINIA, Beckley: National Mine Service, Bemeco Div., P. O. Box 32
Bluefield: Bluefield Hardware Co.
Logan: National Mine Svc., All-State Div., P. O. Box 1671
Charleston: A&I Supply Co., 614 Virginia St. Cummins Engine of W. Va. Box 527 Kanawha Steel & Equipment Co., 112 24th St.
Wheeling: Wheeling Rubber Products Inc., 927 Market St.

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IOWA, Des Moines: Peerless Supply Co.
KENTUCKY, Harlan: McCombs Supply Co.
Madisonville: Mine Equipment & Supply
MICHIGAN, Iron Mountain: W. B. Thompson Co.
NEW MEXICO, Carlsbad: Carlsbad Supply Co.
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Rochester: Brace-Mueller-Huntley Inc.
Syracuse: Brace-Mueller-Huntley, Inc.
OHIO, St. Clairsville: Oglebay Norton Mine Supply Div.
OKLAHOMA, McAlester: Gladstein Co.
Picher: Consolidated Supply Co.
PENNSYLVANIA, Washington: Oglebay, Norton Mine Supply Div.
Johnston: Oglebay Norton Mine Supply Div.
Uniontown: Tri-State Mine Supply Co.
TENNESSEE, Jellico: McCombs Supply Co.
Whitewell: Marion Mine & Mill Supply Co.
UTAH, Helper: Carbon Transfer & Supply Co.
WEST VIRGINIA, Charleston: Persinger's Inc.
Williamson: Persinger Supply Co.
Bluefield: Bluefield Hardware

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MASSACHUSETTS, Waltham 54: 11 Sun St.
NEW JERSEY, Newark 2: 30 Warren Pl.
PENNSYLVANIA, Pittsburgh 18: 2437 Waverly St., Swissvale

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Champaign: Depke Welding Supplies
Kankakee: Depke Welding Supplies
Rockford: Welders Supply Co., 806 Broadway
INDIANA, Brazil: Shaffer & Co., E. National at Murphy Ave.
Evansville: The Hoprich Co., 1005 N. Governor St.
Indianapolis: Allied Weld-Craft, Inc., 401 W. South St.
Terre Haute: Mineweld Co. of Indiana, Inc., 1339 N. 13th St.
KENTUCKY, Harlan: Kentucky Mine Supply Co.
Louisville: 2917 Richland Ave.
MISSOURI, St. Louis 14: Hill Equipment Co., 1413 Penna. Ave., "Pagedale"
OHIO, Bridgeport: General Welding Co., 310-318 Main St.
Canton: Ohio Air Products of Canton, 2350 13th St., N.E.
Canton: Welders Supply Co., 1601 W. Tuscarawas St.
Cincinnati: Baker Welding Supply, 3349 Montgomery St.
Cleveland: Wolfenden Welding Supplies, Inc., 3500 Prospect Ave.
Columbus 8: Franklin Supply Co., 1260 W. Mound St.
Elyria: Elyria Welding Supply Co., 118 Kipling St.
Marietta: Virginia Welding Supply Co., Warner St.
Zanesville: Dunlap Welding & Supply, 720 Marietta St.
TENNESSEE, Nashville: Welding Gas Products Co., 516 Fifth Ave.
VIRGINIA, Lynchburg: Jones Welding Supplies
Roanoke: Jones Welding Supplies, 225 Eleventh St., S.E.
WEST VIRGINIA, Bluefield: Pocahontas Welding Supply
Charleston: Virginia Welding Supply Co., 114-116 Virginia St., E.
Huntington: Virginia Welding Supply Co.
Parkersburg: Virginia Welding Supply Co., 126 19th St.

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IOWA, Davenport: 601 Brady St., Phone 2-6243
MASSACHUSETTS, Worcester 8: 22 Pleasant St., Room 201, Pleasant 7-8371
MICHIGAN, Detroit 2: 610 New Center Bldg., Trinity 1-8100

MISSOURI, Kansas City 5: 2300 Power & Light Bldg., Victor 2-2822
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OHIO, Akron 8: 506 Akron Savings & Loan Bldg., Jefferson 5-7138
Cincinnati 6: 2331 Victory Parkway, Capital 1-7000
Cleveland 13: 1450 Terminal Tower, Cherry 1-6880
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Pittsburgh 19: 1501 Alcoa Bldg., Atlantic 1-4545
York: 205 Manufacturing Bldg.
TENNESSEE, Chattanooga 2: 1205 Volunteer Bldg., Amherst 7-6585
WISCONSIN, Milwaukee 3: 505 Bockl Bldg., 2040 W. Wisconsin Ave., Division 2-7110

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Denver 16: Metal Goods Corp., 4343 Holly St.
ILLINOIS, Chicago 80: Central Steel & Wire Co., P.O. Box 5310A
Chicago 80: Steel Sales Corp., 3348 S. Pulaski Rd.
Chicago 50: Corey Steel Co., 2800 S. 61st Court
INDIANA, Indianapolis 18: Steel Sales Corp., 2185 N. Sherman Dr.
MISSOURI, N. Kansas City: Marsh Steel Corp., 101 E. 9th St.
N. Kansas City: Metal Goods Corp., 1300 Burlington Ave.
St. Louis 14: Metal Goods Corp., 8800 Page Bldg.
St. Louis 10: Steel Sales Corp., 4565 McRee Ave.
OHIO, Cincinnati 29: Williams & Co. Inc., 3221 Fredonia Ave.
Cincinnati 14: Central Steel & Wire Co., Box 148 Annex Station
Cleveland 2: Nottingham Steel & Aluminum Co., 4510 Division Ave.
Cleveland 14: Williams & Co., 3700 Perkins Ave.
Columbus 8: Williams & Co., 851 Williams Ave.
PENNSYLVANIA, Philadelphia 34: Edgcomb Steel Co., D St.
Philadelphia 40: Whitehead Metal Products Co., Inc., 1955-75 Hunting Park Ave.
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ILLINOIS, Broadview: 2651 Gardner Rd., Fillmore 5-0320
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MINNESOTA, Minneapolis 2: 1002 Baker Bldg., Federal 9-5893
MISSOURI, Kansas City 5: Room 926, 20 West 9th St. Bldg., Victor 2-8427
St Louis 9: 3351 Lawn Ave., FI 1-8977
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OHIO, Cleveland 30: 7586 Webster Rd., Berea 4-3078

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KENTUCKY, Lexington: Industrial Division, Womwell Automotive Parts Co., Inc. 240 Clark St.
Louisville: Henderson Rubber Co., 1010 Clarks Lane
OHIO, Cincinnati 37: Queen City Supply Co., 7676 Rienhold Drive
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Knoxville: Browning Belting & Supply Co., Inc. 205 North Central
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WEST VIRGINIA, Bluefield: Bluefield Supply Co.

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INDIANA, Vincennes: Oren R. Gulley, 1648 N. 13th St., 1183
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MICHIGAN, Ishpeming: Charter Inc., 115 S. 1st St., Hudson 6-4471
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Cincinnati 37: W. W. Baerbalck & Associates, 7719 Reading Road, Room 2
Cleveland 18: Alan Moore & Co., 3109 Mayfield Rd., No. 207
PENNSYLVANIA, Cheltenham: C. V. McQuarry, Box 52
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OHIO, Columbus: Billy C. Lykins, 2770 Linview Ave., Amherst 8-9419
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Charleston: Donald C. Bailey, 3901 McCorkle Ave., Walnut 5-4176

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ILLINOIS, Chicago: 1606 Feld Bldg., 135 S. LaSalle St., Franklin 2-9530
MISSOURI, Joplin: 612 First National Bldg., Mayfair 4-924
PENNSYLVANIA, Pittsburgh: 1544 Oliver Bldg., Atlantic 1-2684
Tamaqua: 601 Schuykill Ave., Phone 1300
Wilkes-Barre: 1026 Miners Bank Bldg., Valley 3-2516
TENNESSEE, Knoxville: 813 Hamilton National Bank Bldg. Phone 2-2147
WASHINGTON, Seattle; 1320 Joseph Vance Bldg., Main 2-5110

DISTRIBUTORS

ILLINOIS, Lenzburg: Superior Explosives Co., Phone New Athens, Ill., 215
Marion: Superior Explosives Co., Mr. Ed Cash, 511 E. Main St., Phone 834
Quincy: Quincy Supply Co., 700 S. Front St. Baldwin 3-1171
INDIANA, Brazil: Hoosier Explosives Co., 26-28 S. Walnut St. Phone 2391
New Albany: C. L. Graf, Inc., 431 Pearl St., Whitehall 4-1113
KENTUCKY, Barbourville: Blair-Noonan Co.
Prestonburg: Prestonburg Explosive Co., Phone 2345
OHIO, Berlin: Yoder Hybrid Corn Co.
Canton: Apex Powder Corp., 1545 Waynesburg Rd., S.E.
Oak Hill: Oak Hill Powder Supply Co.
PENNSYLVANIA, Brockway: Beadle Corp.
Clarion: Amos L. Dolby
Clymer: Longwill Mine Supply Co. 56 Morris St.
Listie: Edward Steinkirchner
Meyersdale: Shipley Hardware Co.
Philipsburg: John F. Mitchell Cold Stream
Ramey: Williams Powder Co.
Sidman: George H. Miller
Six-Mile Run: Ralph M. Shuke
Tyler: Patsy Georgino & Son
Uniontown: George F. Buerger 656 Bierer Lane
TENNESSEE, Chattanooga: Mill & Mine Supply Co.
La Follette: Card Explosives Co., Phone 85
Pikeville: Four Way Store Gilbert 7-5710
S. Pittsburg: Paul's Food Market, Temple 7-7551
Whitewell: Marion Mine & Mill Supply Co., Wholesale Co.
VIRGINIA, Big Rock: Buchanan
Grundy: Bevins-Atlas Co., P. O. Box 1168
Norton: Witaker-Atlas Supply Co., Phone 1263
WASHINGTON, Seattle: Carrington Co., 91 Columbia St.
WEST VIRGINIA, Beckley: West Virginia Explosives Co., Cl 2-7061
Bluefield: Bluefield Hardware Co., 400 Bluefield Ave.
Bluefield Supply Co., 100 Mercer St., Phone 6121
Enterprise Trucking Co., Davenport 7-2361
Clarksburg: Atlas Supply & Equip. Co., Inc., 309 N Fourth St.
Charleston: W. Virginia Explosive Co., Riverside 4-5521
East Rainelle: Greenbrier Explosive Co., He 8-7171
Lewisburg: Midland Explosives & Equip. Co.
Sutton: A. L. Rose & Co.

AUTOMATIC VULCANIZERS CORP.

16 Hudson St., New York 13, N.Y.

DISTRIBUTORS

ILLINOIS, Chicago 2: Pang Sales CO., 55 E. Washington St.
MICHIGAN: Howard City: Pang Vulcanizing Supply, 224 Sherman St.
NEW YORK (& PENNSYLVANIA), New York: Pang Chemical Vulcanizers, 322 W. 72 St.
OHIO, Cleveland 15: Pang-Ohio, Inc. 204 Carnegie Hall
WEST VIRGINIA, Pang Distributing Co., Box 22, Langeloth, Penna.

B

BETHLEHEM STEEL COMPANY

Bethlehem, Pa.

DISTRICT SALES OFFICES

GEORGIA, Atlanta 1: J. E. McQueen, 1312 Fulton National Bank Bldg., 55 Marietta St.
ILLINOIS, Chicago 1: E. H. Gumbart, 2700 Prudential Bldg., Prudential Plaza

Herrin: Hugh S. Dawson, 500 W. Monroe St.
MARYLAND, Baltimore 3: S. C. Husted, 1600 Commercial Credit Bldg., 300 St. Paul Place
OHIO, Cincinnati 2: O. W. Buenting, 1401 Fifth Third Bank Bldg., 4th & Walnut Sts.
Cleveland 13: F. W. West, Jr., 2700 Terminal Tower, 50 Public Square
PENNSYLVANIA, Bethlehem: J. D. Mixsell, Res. Repr., 701 E. 3rd St.
Johnstown: L. M. Donnelly, Res. Repr., Bethlehem Bldg., 119 Walnut St.
Philadelphia 3: R. S. Taylor, 1058 Suburban Sta. Bldg., 1617 Penna. Blvd.
Pittsburgh 22: R. T. Eaton, 1200 Oliver Bldg., Mellon Square
TENNESSEE, Knoxville: J. Watkins, Jr., Box 1229
UTAH, Salt Lake City 11: L. B. Gillette, Executive Bldg., 455 E. 4th South
WEST VIRGINIA, Bluefield: E. W. Outten, 2415 Bland Rd.
Charleston: L. C. Scheifly, One Morris Apts., 1 Morris St.
Charleston: L. R. Schoffstall, 909 Chappel Rd., S.E.

BIRD MACHINE CO.
South Walpole Mass., Montrose 8-0400

DISTRICT SALES OFFICES
GEORGIA, Atlanta 9: 1430 West Peachtree St., N. W.
ILLINOIS, Evanston: 603 Main St.
WEST VIRGINIA, Huntington: 438 13th Ave.

BIXBY-ZIMMER ENGINEERING CO.
961 Abingdon St., Galesburg, Ill.

BOWDIL CO., THE
Boylan Ave. S.E., Canton 7, Ohio, Glendale 6-7176

DISTRICT SALES OFFICES
COLORADO, Denver: Wm. Radcliff, 761 Steele St., EA 2-7151
ILLINOIS, West Frankfort: Randal A. Leach, 1004 E. St. Louis St., Phone 675
KENTUCKY, Whitesburg: A. J. Leach, Sand Lick Rd. Phone 2232
NEW MEXICO, Carlsbad: Wenzel's Parts Service, Box 464
OHIO, Magnolia: C. W. Weisburn, UN 6-2166
PENNSYLVANIA, Perryopolis: J. M. Biasco, North Liberty Ave., Redfield 6-2575
WEST VIRGINIA, Danville: E. D. Caudill, Box 132, Phone 810
UTAH, Helper: V. L. Waldington, Phone 144
CANADA, Drumheller, Alberta: Webb Distributors, Ltd.

BRODERICK & BASCOM ROPE CO.
4203 Union Blvd., St. Louis 15, Mo.

DISTRICT SALES OFFICES
COLORADO, Denver: Mine and Smelter Supply Co., 3800 Race St.
GEORGIA, Atlanta 10: Broderick & Bascom Rope Co., 680 Murphy Ave., SW
ILLINOIS, Melrose Park: Broderick & Bascom Rope Co., 2045 N. 15th Ave.
KENTUCKY, Harlan: Kentucky Mine Supply Co.
OHIO, Youngstown 12: Mahoning Valley Supply Co., 704 Youngstown-Poland Rd.

C

CARRIER CONVEYOR CORP.
254-A N. Jackson St., Louisville, Ky.

CATERPILLAR TRACTOR CO.
Peoria, Ill.

CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.
146 President St., St. Louis 18, Mo., PR 62848

DISTRICT SALES OFFICE
PENNSYLVANIA, Irwin: 49 Woodall Ave., Un 3-3228
WEST VIRGINIA, Huntington: 925 6th Ave., Jackson 9-4131

CHEATHAM ELECTRIC SWITCHING DEVICE CO.
4780 Crittenden Dr., Louisville 9, Ky., Emerson 3-3671

SALES OFFICES
UTAH, Salt Lake City: 375 South West Temple, DA 2-4311

CHICAGO PNEUMATIC TOOL CO.
6 East 44th St., New York 17, New York
ALABAMA, Birmingham 4: 810 Fifth Ave., No.
CALIFORNIA, Los Angeles 22: 6935 Bandini Blvd.
South San Francisco: 145 Mitchell Ave.
COLORADO, Denver 4: 465 Acoma St.
GEORGIA, Atlanta 9: 91-16th St., N.W.
ILLINOIS, Chicago 19: 1936 East 87th St.
MICHIGAN, Detroit 26: 570 East Larned St.
MISSOURI, St. Louis 17: 8029 Lizinger Road
PENNSYLVANIA, Pittsburgh: 369 Coltart Ave.

DISTRIBUTORS
ILLINOIS, Peoria: Dooley Bros., 1201 S. Wahington St.
INDIANA, Evansville 5: Austin Powder Co., 616 N.W. 2nd St.
Terre Haute: Advance Electrical Co., 545 N. 6th St.
Terre Haute: Mine Supply Co., 417 N. 13th St.
KENTUCKY, Harlan: Kentucky Mine Supply Co.
Harlan: McComb Supply Co.
Lothair: Mine Supply Co.
PENNSYLVANIA, Johnston: M. Glosser & Sons, Inc., 72 Messenger St.
Johnston: Penn Machine Co.
Scranton 9: L. A. Harding Co. 1625 Nay Aug Ave.
TENNESSEE, Jellico: McComb Supply Co.
UTAH, Salt Lake City 1: 146 West Fourth South
VIRGINIA, Grundy: Buchan-Williamson Supply Co.
McClure: Erwin Supply & Hardware Co.
WEST VIRGINIA, Charleston 27: Persingers, Inc., P. O. Box 1866
Fairmont: Fairmont Supply Co., 10th & Belt Line
Huntington: Ensign Electric & Mfg. Co., 914 Adams Ave.
Williamson: Persingers Supply Co.
Williamson: Williamson Supply Co.

CIRCLE WIRE & CABLE CORP.,
CORP., Subsidiary of CERRO DE PASCO CORPORATION, 5500 Maspeth Avenue, Maspeth, New York Evergreen 6-5500

SALES OFFICE & WAREHOUSE
COLORADO, Denver: 211 Wazee Street, Acoman 2-4893
MARYLAND, Baltimore: Burg & Ellen, 526 E. Monument St., Mulberry 5-3633
MISSOURI, St. Louis 8: Gene Hagen & Company, 4232 Forest Park, Olive 2-1036
NEW MEXICO, Albuquerque: Sales Engineers, Inc.: 721 Loma Vista Drive, Alpine 5-9625
OHIO, Cincinnati: Block & Cooper, 1050 Meta Drive, Redwood 1-2196
PENNSYLVANIA, Philadelphia: 923 Locust Street, Center 6-0121
Pittsburgh: H. W. Groetzinger & Co., 410 E. Gen'l. Robinson St., Alleghany 1-6280

CLEVELAND WIRE CLOTH & MFG. CO.
3572 E. 78th St., Cleveland 5, Ohio

COLLYER INSULATED WIRE CO.
245 Roosevelt Ave., Pawtucket, R.I.

COLUMBUS MCKINNON CHAIN CORP., MINING EQUIPMENT DIVISION
52 Fremont Avenue, Tonawanda, N. Y.

DISTRIBUTORS
ALABAMA, Birmingham 5: J. L. Thomas Company, 429 South 24th Street, FA 4-7032
NEW MEXICO, Carlsbad: Carlsbad Supply Company, 501 Park Drive., P.O. Box 1042, Tuxedo 5-3636
PENNSYLVANIA, Pittsburgh: McKees Rocks, Schroeder Bros. Corp., Nichol Avenue, Box 72, Spalding 1-4810
UTAH, Salt Lake City: National Equipment Company, P. O. Box 1767

COMBUSTION ENGINEERING INC., RAYMOND DIV.
1315 N. Branch St., Chicago 22, Ill.

DISTRICT SALES OFFICES
NORTH CAROLINA, Charlotte: Addison Bldg., 222 South Church St.
OHIO, Cincinnati 2: 1101 Enquirer Bldg.
Cleveland 13: 733 The Illuminating Bldg.
PENNSYLVANIA, Philadelphia 2: 2 Penn Center Plaza
Pittsburgh 22: 1 Gateway Center

CRESCENT BELT FASTENER CO.
381 Fourth Ave., New York 16, N.Y.

DISTRIBUTORS
ALABAMA, Birmingham: Moore-Handley Hardware Co., Inc., 27 So. 20th St.
Birmingham: Young & Vann Supply Co., 1731 First Ave. North
COLORADO, Denver: Hendrie & Bolthoff Co., 1635 Seventeenth St.
Denver: Mine & Smelter Supply Co., 3800 Race St.
IOWA, Des Moines: Globe Machinery & Supply Co., East First & Court Ave.
KENTUCKY, Louisville: Belknap Hardware & Mfg. Co., 111 East Main St.
Paducah: Henry A. Petter Supply Co.
MISSOURI, Joplin: Joplin Supply Co.
Kansas City: Webb Belting & Supply Co., 1501 West 12th St.
NEW MEXICO, Albuquerque: Hendrie & Bolthoff Co.
OHIO, Columbus: The Ross-Willoughby Co., 1400 Goodale Blvd.
Hamilton: Fischer Hardware & Supply Inc., 20 North Third St.
Toledo: The Bostwick-Braun Co., Summit & Monroe
OKLAHOMA, Picher: Consolidated Supply Co.
OREGON, Portland: General Rubber & Supply Co., 2258 N.W. Raleigh
PENNSYLVANIA, Easton: Victor Balata & Textile Belting Co.
Philadelphia: D. P. Brown & Co., Inc., Byberry Rd. West of Roosevelt Blvd.
Pittsburgh: Pittsburgh Gage & Supply Co., 3000 Liberty Ave.
Pittsburgh: C. A. Turner, Inc., P.O. Box 8620
York: Fulton-Mehring, & Hauser Co., Inc., 235 North Beaver St.
TENNESSEE, Chattanooga: Chattanooga Belting & Supply Co., 1221 Market St.
Memphis: Pidgeon-Thomas Iron Co., E. H. Crump Blvd. at South Main
Nashville: Keith-Simmons Co., Inc., P.O. Box 1030
TEXAS, Dallas: Briggs-Weaver Machinery Co., 5000 Hines Blvd.
El Paso: Momsen Dunnegan Ryan Co.
San Antonio: San Antonio Machine & Supply Co., 301 Center St.
UTAH, Salt Lake City: Mine & Smelter Supply Co.
VIRGINIA, Norfolk: Tidewater Supply Co., 501 West 24th St.
WASHINGTON, Tacoma: Washington Belting & Rubber Co., 672 East 11th St.
WEST VIRGINIA, Huntington: Banks-Miller Supply Co., 330 Third Ave.

CUMMINS ENGINE CO., INC.
1000 Fifth St., Columbus, Indiana

DISTRICT SALES OFFICES
COLORADO, Denver 2: 1726 Champa St., AComa 2-3685
GEORGIA, Atlanta 5: 359-61 East Paces Ferry Rd., N.E., Cedar 7-9231
ILLINOIS, Chicago 3: 8 South Michigan Ave., FRanklin 2-9838
MINNESOTA, Minneapolis 2: 1910 Rand Tower, FEderal 3-7279
MISSOURI, St. Louis 3: 1221 Locust St., MAin 1-6575
NORTH CAROLINA, Greensboro: 601 North Elm St., BRoadway 2-5142
OHIO, Cleveland 14: 501 Fidelity Bldg., CHerry 1-5435
PENNSYLVANIA, Harrisburg: 3rd and State Streets, CEdar 2-4441
CANADA, Toronto 9, Ontario: 2489 Bloor St., West, ROger 2-8397

CURTISS-WRIGHT CORP., SOUTH BEND DIV.
701 W. Chippewa Ave., South Bend, Indiana

DISTRICT SALES OFFICES
INDIANA, Fort Wayne: 1836 Rosemont Dr., Eastbrook 9981
KENTUCKY, Lexington: 405 No. Side Dr., Tel: 2-1691
NEW JERSEY, Hackettstown: 125 E. Prospect Ave., Garden 5-3098
WEST VIRGINIA, Parkersburg: 2907 Fairview, Box 1393, HU 5-7175

DISTRIBUTORS
KENTUCKY, Lexington: Wilson Machinery and Supply Co., 550 West Fourth St., Tel: 3-1450
Louisville: P.O. Box 165, Buechel Substation, Bishop Lane, Glendale 8-5394
Owensboro: 2601 West Fourth St., Murray 4-3226
OHIO, Columbus 19: Cantwell Machinery Co., 830 North Cassady Ave., Clearbrook 8-9561
VIRGINIA, Richmond 27: Capital Equipment Co., Inc., 2050 Westmoreland St., (P.O. Box 9246), Elgin 5-1789
Roanoke: 3372 Shendoah Ave., N.W., Diamond 2-6764
WEST VIRGINIA, Huntington: Porter Supply Co., Inc., 1703 Seventh Ave., (P.O. Box 736), JA 2-6651

D

DEISTER CONCENTRATOR CO., INC.
909 Glasgow Ave., Fort Wayne, Ind.

DISTRICT SALES OFFICES
ALABAMA, Birmingham: 2612 N. 24th St.

CALIFORNIA, Los Angeles: 2020 Sacramento St.
NEW YORK, New York 4: 60 Beaver St.
PENNSYLVANIA, Nesquehoning: 35 E. Center St.

DENVER EQUIPMENT CO.
P.O. Box 5268, Denver 17, Colo.
NEW YORK, New York City: 4114 Empire State Bldg., CH 4-6510
WEST VIRGINIA, Bluefield: P.O. Box 1119, DAvenport 5-6598

DIFFERENTIAL STEEL CAR CO.
CO.
Findlay, Ohio

DOWELL DIV., DOW CHEMICAL CO.
1918 Highway 41 North, Evansville 7, Ind.

DOWTY MINING LTD.
CANADA, Ajax, Ontario
ENGLAND, Cheltenham, Dowty Mining Ltd.

DRAVO CORP.
Neville Island, Pittsburgh 25, Pa.

DU PONT DE NEMOURS & CO., E. I. (EXPLOSIVES DIV.)
Bloomington, Del.

DU PONT DE NEMOURS & CO., E. I., ELASTOMER CHEMICALS DEPT.
Wilmington 98, Del.

E

ESSO STANDARD DIV. OF HUMBLE OIL & REFINING CO.
15 West 51st St., New York 19, N.Y.

DISTRICT SALES OFFICES
PENNSYLVANIA, Avoca: R.D. #2 Suscon Rd., OLympic 4-4669
Bala Cynwyd: City Line Ave. & Esso Rd., TRinity 8-0700
Indiana: Indiana Bulk Plant, Homer City Rd., Route 119, Indiana-Hopkins 5-5608
E. Freedom: East Freedom Bulk Plant, Route 220, Blair County, Hollidaysburg-Owen 5-9815
Johnstown: 335 Swank Bldg., Main & Bedford Streets, Tel: 7-5197
Pittsburgh: Box 4043 Arsenal Station, Museum 2-6613
Reading 2: Reading Bulk Plant, Pottsville Pike, Berks County, Walker 9-0753
TENNESSEE, Chattanooga: Bonny Oaks Drive, MA 4-1561
Knoxville: 5009 Middlebrook Pike, N.W., Tel: 8-4611
Memphis: 328 Wisconsin Ave., WH 8-5691
Nashville: 1728 28th Ave., N., AL 5-0406
VIRGINIA, Bluefield, FAirfax 6-1213
Norton: Tel: 114
Richlands: WO 1-7475
Roanoke 9: 907 Seventh St., N.E., Diamond 2-8951
WEST VIRGINIA, Beckley: Box 1132, CLifford 3-3811
Charleston 2: McCorkle & Standard Streets, Dickens 2-8172-4-5 or 6
Fairmont: Box 32, Tel: 2420
Huntington: JAckson 3-3481
Logan: PL 2-2660
Morgantown: P.O. Box 801, MOrgantown 5515
Rainelle: HE 8-8581
Warwood: Wheeling Bulk Plant, CRestview 7-1300

EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO.
Rising Sun & Adams Ave., Philadelphia 20, Pa.

DISTRICT SALES OFFICES
ALABAMA, Birmingham 9: 1925 29th Ave. S., Tremont 9-5321
COLORADO, Denver 2: 1515 Cleveland Pl. So., Suite 200, Main 3-7793
DISTRICT OF COLUMBIA, Washington 16: 4000 Albemarle St., N.W., Emerson 2-6800
GEORGIA, Atlanta 10: 1246 Allene Ave. S. W., Plaza 8-2621
ILLINOIS, Chicago 9: 5335 S. Western Blvd., Walbrook 5-9800
Peoria: 423 1st Nat'l Bank Bldg., Phone 4-5051
INDIANA, Indianapolis 4: 325 Bankers Trust Bldg., Melrose 5-6727
MISSOURI, Kansas City 23: 129 S. Belmont Blvd., Benton 1-6300
St. Louis 8: 3928 Lindell Blvd., Olive 2-1310
NEW YORK, New York 36: 25 W. 43rd St., Bryant 9-8100
NORTH CAROLINA, Charlotte 2: 519 E. Trade St., Franklin 5-7966
OHIO, Cincinnati: 6531 Rollymead Rd. MAin 1-1435
Cleveland 14: 2225 Hamilton Ave., Cherry 1-6231
OREGON, Portland 5: 1224 S.W. Morrison St., Capital 2-3778
PENNSYLVANIA, Philadelphia: 5675 Rising Sun Ave., Fidelity 2-2222
Pittsburgh 16: 1608 Potomac Ave., Fieldbrook 1-2832
TENNESSEE, Memphis: 420 Dermon Bldg., Jackson 6-5842
TEXAS, Dallas 1: 2133 McKinney Ave., Riverside 8-9977
UTAH, Salt Lake City 7: P.O. Box 133, Murray Branch, Elgin 9-5766
WASHINGTON, Seattle 1: 500 Wall St., Main 3-1377.
Spokane 1: 617 Paulsen Bldg., Madison 4-1295
WEST VIRGINIA, Charleston: P. O. Box 1562, Dickens 6-8201

F

FAIRMONT MACHINERY CO.
Fairmont, W. Va., Fairmont 1672

FAIRVIEW BIT CO., INC.
Fairview, West Virginia

DISTRIBUTORS
ALABAMA, Birmingham: National Mine Service Co., Vestavia Hills, VA 2-0320
NEW MEXICO, Carlsbad: Bit Grinding Service, East Orchard Lane, P.O. Box 803, TU 5-6113
PENNSYLVANIA, Indiana: National Mine Service Co., 1260 Maple St., HO 3-0231
Washington: Fairmont Supply Co., BA 2-5204
WEST VIRGINIA, Beckley: National Mine Service Co., P.O. Box 32, CL 3-7324
Bluefield: U.S. 52 North, Davenport 5-6186
Fairmont: 10th and Belt Line, 2110

THE FALK CORP.
Milwaukee 1, Wisconsin

DISTRICT SALES OFFICES
ALABAMA, Birmingham 3: Brown-Marx Bldg., Room 649, Fairfax 4-1433
ILLINOIS, Chicago 3: 105 W. Adams St., State 2-6686
Peoria: 800 S. W. Adams St., Phone 6-0433
INDIANA, Indianapolis 29: 6349 Guilford Ave., Clifford 5-5434
MARYLAND, Baltimore 12: 4231 Greenmount Avenue, Tuxedo 9-4969
MISSOURI, St. Louis 5: 8029 Forsyth Blvd., Parkview 5-8300
Kansas City 8: (B. L. McCreary & Son) 1819 Central St., Harrison 1-1668
NEW JERSEY, Newark 2: 100 Parkhurst St., Bigelow 2-5300
OHIO, Akron 9: (B. W. Rogers Co.) P.O. Box 1030, Portage 2-0251
Cincinnati 2: 609 American Bldg., Main 1-2364
Cleveland 24: P.O. Box 4506, Hillcrest 2-5656
Columbus 12: P.O. Box 5044, Hudson 8-0531
PENNSYLVANIA, Pittsburgh 34: 300 Mt. Lebanon Blvd., Suite 200B, Locust 3-1754
Wynnewood: P.O. Box 313, Midway 9-3335
TENNESSEE, Knoxville 17: (Bowditch & Co.), 1311-C Broadway, N.E., Phone 4-2513
VIRGINIA, Richmond 19: (Williamson & Wilmer), 617 Mutual Bldg., Milton 3-9003
WEST VIRGINIA, Charleston 2: P.O. Box 10066, Riverside 4-1821

FARRELL-CHEEK STEEL COMPANY
Sandusky, Ohio, Main 5-2340

SALES AGENTS
ALABAMA, Birmingham: Ebbert & Kirkman Co., Inc., 2313 6th Ave., South Alpine 1-9174
FLORIDA, Tampa 3: Minich-Du-Von Corp., 2509 West Hillsboro Ave., P.O. Box No. 7292, Redwood 6-0749 & Redwood 7-1983
ILLINOIS, Chicago 40: Mr. Laurence J. White, Uptown Bank Bldg., Long Beach 1-6655
MASSACHUSETTS, Newton Lower Falls: Ward Weller Co., Inc., 2276 Washington St.
NEW JERSEY, Hoboken: Mr. J. J. Murray, Hudson County National Bank, 95 River St., P.O. Box 150-MO, Oldfield 9-1241
OHIO, Springfield: Mr. Mel Conwell, 109 Bellevue Ave., Fairfax 3-6120
PENNSYLVANIA, Philadelphia 32: Mr. Henry A. Smith, 2727 N. 15th St., Baldwin 8-1420
Pittsburgh 22: Mr. Geo. C. Hutchinson Jr., 800 Keenan Bldg., Atlantic 1-5860
TENNESSEE, Memphis 11: Mr. Hunley A. Slaughter, Box 6403, East Station, 185 Alexander St., Glendale 2-4278
TEXAS, Dallas 5: R. C. Brown Co., P.O. Box 8026, Emerson 8-2866
Houston 8: 515 W. 11th St., UN 1-1277

FEDERAL-MOGUL SERVICE DIV., FEDERAL-MOGUL-BOWER BEARINGS, INC.
11031 Shoemaker Ave., Detroit 13, Michigan

DISTRICT SALES OFFICES
GEORGIA, Atlanta 8: 24 Linden Ave., N.W., Trinity 2-3532
ILLINOIS, Chicago 16: 1923 So. Calumet Ave., Victory 2-2488
INDIANA, Indianapolis 4: 601 N. Capital Ave., Melrose 7-5541
MISSOURI, Kansas City 16: 1313 Atlantic Ave., Victor 2-1047
PENNSYLVANIA, Philadelphia 30: 1839 Wylie St., Poplar 9-2812
Pittsburgh 6: 5472 Penn Ave., Montrose 1-6664
TENNESSEE, Memphis 5A: 905 Estival Place, Jackson 5-0877
VIRGINIA, Richmond 21: 3407 W. Leigh St., Elgin 5-1751

FEMCO, INC.
Irwin, Pa.

DISTRIBUTORS
ALABAMA, Birmingham: National Mine Service Co.
KENTUCKY, Ashland: National Mine Service Co.
Jenkins: National Mine Service Co.
Madisonville: National Mine Service Co.
PENNSYLVANIA, Forty Fort: National Mine Service Co.
Indiana: National Mine Service Co.
Pittsburgh: National Mine Service Co., 564 Alcoa Bldg.
UTAH, Salt Lake City: Industrial Physics & Electronics Co.
WEST VIRGINIA, Beckley: National Mine Service Co.
Logan: National Mine Service Co.
Morgantown: National Mine Service Co., 564 Alcoa Bldg.

FIRESTONE TIRE & RUBBER CO.
12 So. Main St., Akron, Ohio

FLOOD CITY BRASS & ELECTRIC CO.
Messenger & Elder Sts. Johnstown, Pa. Phone 7-8919

SALES AGENTS
ALABAMA, Birmingham 1: Salmon & Co., Inc., P.O. Box 2388
WEST VIRGINIA, Montgomery: Marathon Coal Bit Co., Inc. P.O. Box 391, HI 2-2478

FULLER MFG. CO.
Kalamazoo, Mich.

G

GATES RUBBER CO.
999 S. Broadway, Denver, Colo.

GOODMAN MANUFACTURING CO.
Halsted St. & 48th Place, Chicago 9, Illinois

DISTRICT SALES OFFICES
ALABAMA, Birmingham 4: 812 Fifth Avenue, Fairfax 3-3222
ILLINOIS, West Frankfort, 304 W. Main St.
KENTUCKY, Harlan, P.O. Box 799, Phone 416
PENNSYLVANIA, Pittsburgh 33: 1714 Liverpool St., Cedar 1-1356
Wilkes-Barre: 35 New Bennett St., Valley 3-3013
WEST VIRGINIA, Huntington 16: 831 Second Ave., Jackson 5-9189

SALES AGENTS
AUSTRALIA: John Carruthers & Co., Pty. Sydney
BRAZIL: Formac, S. A., Rio de Janeiro
CANADA: Wing Equipment, Ltd., Vancouver, B.C.
ENGLAND: Distington Engineering Co., Ltd., Workington, Cumberland
FRANCE: S. E. T. I. S., Paris 9
INDIA: Blackwood Hodge, Ltd., Calcutta
JAPAN: C. T. Takahashi & Co., Tokyo
TURKEY: Kutsi Begdes, Istanbul
UNION OF SOUTH AFRICA: Johannesburg Hubert Davies & Co., Ltd.,

B. F. GOODRICH INDUSTRIAL PRODUCTS
500 So. Main St., Akron 18, Ohio, Blackstone 3-1171

DISTRICT SALES OFFICES
CALIFORNIA, Los Angeles 22: 3525 S. Garfield Ave.
Los Angeles 54: Box 2002, Terminal Annex
San Francisco 24: 1950 Army St.
COLORADO, Denver 4: 2500 W. Eighth Ave.

Denver 1: P.O. Box 417
GEORGIA, Atlanta 6: 1721 DeKalb Ave., N.E.
Atlanta 2: Box 4509
ILLINOIS, Chicago 44: 4646 West Lake St.
KANSAS, Kansas City 15: 830 Kindelberger Rd.
MASSACHUSETTS, Needham Heights 94: 100 Second Ave., P.O. Box 106
MICHIGAN, Allen Park, 16500 Oakwood Blvd.
MINNESOTA, Minneapolis 16: 800 Turners Crossroad
NEW YORK, New York 17: 230 Park Ave.
OHIO, Akron 18: 500 S. Main St.
Columbus 14: 3770 Indianola Ave. P.O. Box 3507
PENNSYLVANIA, Philadelphia 34: 955 E. Erie Ave.
TEXAS, Dallas 2: 1400 Turtle Creek Blvd. P.O. 6185

GOODRICH TIRE CO., B. F., A DIV. OF B. F. GOODRICH CO.
Akron 18, Ohio

DISTRICT SALES OFFICES

ALABAMA, Birmingham 5: 101 S. 12th St., FA 2-0364
COLORADO, Denver 4: 2500 W. 8th Ave. (P.O. Box 417) TA 5-1267
ILLINOIS, Chicago 44: 4646 West Lake St., ES 8-8800
INDIANA, Indianapolis: 1015 E. Michigan St., ME 7-2508
KANSAS, Kansas City 15: 830 Kindelberger Rd., MA 1-4400
Wichita 11: 902 E. Indianapolis St., (P.O. Box 3826), HO 4-6389
MISSOURI, St. Louis 10: 5051 Southwest Ave., PR 3-2600
NEW YORK, New York 17: 230 Park Ave., OR 9-0330
NORTH DAKOTA, Fargo: 1213 Northern Pacific Ave., AD 2-7462
OHIO, Cincinnati 27: 2929 Exon Ave., BR 1-7800
Cleveland 35: 15593 Brookpark Rd., CL 2-2315
Columbus 14: 3770 Indianola Ave., AM 8-8631
OREGON, Portland 10: 4600 N.W. St. Helens Rd., CA 6-3621
OKLAHOMA, Oklahoma City: 301 E. Hill St., JA 5-1587
PENNSYLVANIA, Harrisburg 14: 700 N. Second St., CE 4-5974
Leetsdale: PO 6-2220
Philadelphia 34: 955 E. Erie Ave., (P.O. Box 4743), JE 5-5800
TENNESSEE, Memphis 6: 960 S. Bellevue St., (P.O. Box 5687), WH 8-6761
UTAH, Salt Lake City 4: 651 W. Sixth South St., (P.O. Box 1918), DA 2-2405
VIRGINIA, Richmond 30: Dabney Rd. & Clay St., (P.O. Box 6695), EL 5-6573
WASHINGTON, Seattle 24: 1 Hanford St., MU 2-4300

THE GORMAN-RUPP CO.
Mansfield, Ohio

DISTRIBUTORS

ALABAMA, Birmingham: General Mach. Co.
Birmingham: Mill & Mine Supply Co.
FLORIDA, West Palm Beach: J. P. Carroll
Orlando: Southern Pipe & Supply Co.
Tallahassee: Southern Pipe & Supply Co.
ILLINOIS, Christopher: Hoe Supply Co.
Mt. Vernon: Central Mines Supply Co.
INDIANA, Fort Wayne: Johns Equipment Co.
KENTUCKY, Greenville: Greenville Supply Co.
Harlan: McComb Supply Co.
Lothair: Mine Service Co.
Madisonville: Central Supply Co.
MISSISSIPPI, Jackson: Wholesale Supply Co.
OHIO, Cambridge: Cambridge Machine & Supply Co.
Jackson: Jackson Implement Co.
Lisbon: Lisbon Diesel & Supply Co.
New Philadelphia: Buckeye Machine & Supply Co.
PENNSYLVANIA, Pittsburgh: Weinmann Pump & Supply Co.
Scranton: The Bittenbender Co.
RHODE ISLAND, Ashway, Aetna Engineering
TENNESSEE, Chattanooga: Mill & Supply Co.
Knoxville: Tennessee Mill & Mine Co.
Nashville: Mid-Tenn Supply Co.
WEST VIRGINIA, Bluefield, Bluefield Supply Co.
Bluefield: Superior Sterling Co.
Bluefield: Rish Equipment Co.
Clarksburg: Rish Equip. Co.
Charleston: Rish Equip. Co.
Huntington: West Virginia Pump & Supply Co.
Logan: Guyan Machinery Co.

GUNDLACH MACHINE CO., T. J., DIV. OF J. M. INDUSTRIES
#1 Freedom Drive, Belleville, Ill., Adams 3-7208

SALES AGENTS

COLORADO, Evergreen: Clyde E. Clarkson, General Delivery, Phone 667
ILLINOIS, Chicago: Schonthal & Associates, Suite 309, 224 S. Michigan Ave., Wabash 2-8350
PENNSYLVANIA, Greensburg: Andrew M. Gardner, 626 Park Lane, Phone Temple 4-4346
Philadelphia: A. R. Amos Co., 713 Commercial Trust Building, Rittenhouse 6-3675
WEST VIRGINIA, Huntington 1: Marshall Equipment Co., Box 1367, Phone Jackson 3-8691
Wheeling: Richard M. Wilson, P.O. Box 1198, Phone CE 2-8430

GUYAN MACHINERY CO.
755 Stratton, Logan, W. Va.

H

H & L TOOTH CO.
1540 South Greenwood Avenue, Montebello, Calif.

DISTRIBUTORS

ALABAMA, Birmingham: Leary & Owens Machinery Co., 3600 5th Ave. N.
Montgomery: Leary & Owens Machinery Co., 3165 Mobile Rd.
COLORADO, Denver: Air Renals, Inc., 3301 Walnut St.
ILLINOIS, Salem: John Fabick Tractor Co.
Marion: John Fabick Tractor Co.
INDIANA, Evansville: Reid-Holcomb Co., Inc., Boonville Rd. East
Indianapolis: Reid-Holcomb Co., Inc., 1815 Kentucky Ave.
South Bend: Reid-Holcomb Co., Inc., West Ireland Street
KENTUCKY, Louisville: Williams Tractor Co., 3800 Crittenden Dr.
Paducah: Williams Tractor Co., 8th & Burnett Sts.
MISSOURI, Kansas City: Buchanan Equipment Co., 2645 Southwest Blvd.
St. Louis: J. Fabick Tractor Co., 3100 Gravois Ave.
Sikeston: J. Fabick Tractor Co.
OHIO, Cincinnati: Carroll & Edwards Co., Richmond & McLean Sts.
Cleveland: W. T. Walsh Equipment Co., 12750 Berea Road
Columbus: Capitol Road Machinery Co., 945 West 3rd Ave.
PENNSYLVANIA, Harrisburg: Furnival Machinery Co., 5195 Paxton Street
Pittsburgh: Parkway Machinery Co., 635 Ridge Avenue
TENNESSEE, Chattanooga: Power Equipment Co., 1080 Duncan Ave.
Memphis: Tri-State Equipment Co., 520 Mulberry Ave.
Nashville: Power Equipment Co., 800 6th Ave. N.
UTAH, Salt Lake City: Heiner Equipment Co., 50 W. 7th South
VIRGINIA, Roanoke: J. W. Burress, 1701 Shenandoah Ave., N.W.
WEST VIRGINIA, Charlestown: West Virginia Tractor & Equipment Co.
Clarksburg: West Virginia Tractor & Equipment Co., 100 Wood St.

HARNISCHFEGER CORP., CONSTRUCTION & MINING DIV.
4400 National Ave., Milwaukee 14, Wisc.

HARRISON CO., BRAD
Hillside, Ill.

HAUSER-STANDER TANK CO.
Cincinnati 32, Ohio

HENDRICK MANUFACTURING CO.
Carbondale, Pa.

DISTRICT SALES OFFICES

NEW YORK, New York 7: 30 Church St.
PENNSYLVANIA, Hazelton: Box 315
Pittsburgh: P.O. Box 10540 (35)

SALES AGENTS

MISSOURI, St. Louis: Crandall Ricker Sales Corp., 1169 Paul Brown Bldg.
ILLINOIS, Chicago 5: Mills Engineering Sales, Inc., 407 S. Dearborn St.
PENNSYLVANIA, Philadelphia: The Benson, Suite 112-C Washington Lane & Township Line, Jenkintown, Pa.
Pittsburgh 35: Buckley Associates, P.O. Box 10540
OHIO, Cleveland 21: Arthur C. Baker, 4062 Mayfield Rd.
WEST VIRGINIA, Huntington: J. Y. Smythe, 832 11th Ave.

HERCULES POWDER CO.
900 Market St., Wilmington 99, Delaware, Olympia 8-7211

DISTRICT SALES OFFICES

ALABAMA, Birmingham 3: First National Building, 17 N. 20th St., Alpine 2-0293
CALIFORNIA, Los Angeles 5: 3460 Wilshire Blvd., Dunkirk 7-8151
San Francisco 4: 120 Montgomery St., Yukon 6-2535
ILLINOIS, Chicago 4: McCormick Bldg., 332 S. Michigan Ave., Harrison 7-5230
Bldg., 314-16 W. Superior St., Randolph 2-3335
MISSOURI, Joplin: First National Bank Bldg., 404 Main St., Mayfair 4-4183
NEW YORK, New York 17: 380 Madison Ave., Oxford 70010
PENNSYLVANIA, Pittsburgh 22: 2 Gateway Circle 603 Stanwix St., Grant 1-6171
UTAH, Salt Lake City 1: Kearns Bldg., 136 S. Main St., Empire 4-5513

HEWITT-ROBINS, INC.
666 Glenbrook Rd., Stamford, Conn.

HEYL & PATTERSON, INC.
55 Fort Pitt Blvd., Pittsburgh 22, Pa.

DISTRIBUTORS

WEST VIRGINIA, Charleston 26: Kanawha Manufacturing Co., 1520 Dixie Street

HOSSFELD MANUFACTURING CO.
ROCK DRILL DIVISION
Winona, Minnesota

SALES AGENT

MINNESOTA, Winona: Mr. Fred Schwager, Sales Agency, 356 E. Sanborn St.

HUBER-WARCO CO.
Marion, Ohio

DISTRIBUTORS

ILLINOIS, Chicago, 29: Gil Boers Equipment Company, 7625 South Kedzie Avenue
INDIANA, Lawrence 26: Deeds Equipment Co., Inc., 8015 E. 45th St., P.O. Box 8414
Rochester: Deeds Equipment Company Inc., 913-915 Main Street
KENTUCKY, Louisville, 13: Rudd Construction Equipment Co., Inc., 4344 Poplar Level Raod
NORTH CAROLINA, Charlotte: Spartan Equipment Co., 1922 Bancroft St.
OHIO, Cadiz: The W. W. Williams Company, 700 Lincoln Ave.
Cincinnati 15: The W. W. Williams Co., 641 Reading Road, Reading
Cleveland: The W. W. Williams Co., 18301 Brookpark Road
Columbus 8: The W. W. Williams Co., 835 West Goodale Blvd.
Maumee: The W. W. Williams Co., 1230 Conant Street, P.O. Box 309
PENNSYLVANIA, Corry: Corry Bridge & Supply Co.
Devon: Road Machinery, Inc., U. S. Highway 30
Wilkes Barre: Ensminger & Co.
Mechanicsburg: American Equipment Corporations, York & Allen Streets, P.O. Box 149
Pittsburgh 6: Brinker Supply Co., 6545 Hamilton Avenue
TENNESSEE, Chattanooga: Story Brothers, Inc., 919 Dodds Avenue
Knoxville 18: Story Brothers, Inc., 4130 Clinton Highway, P.O. Box 4166
Memphis: Southland Tractors, Inc., 404 East Mallory Ave., P.O. Box 3187
Nashville 4: McCarthy, Jones & Woodward, 723 Argyle Ave., P.O. Box 9068
VIRGINIA, Richmond 12: Municipal Sales Co., Inc., 1823 North Hamilton Ave., P.O. Box 1518
WEST VIRGINIA, Huntington: Porter Supply Co., 1703 Seventh Ave.

HULBURT OIL & GREASE CO.
Trenton & Castor Avenues, Philadelphia 34, Pa.

DISTRICT SALES OFFICES

LLINOIS, Carbondale: P.O. Box 519, Glenview 7-2329
West Frankfort: P.O. Box 59, Tel. 867 M
KENTUCKY, Harlan: P.O. Box 611
Madisonville: 645 Suthard Dr., Taylor 1-4485
Pikeville: P.O. Box 499 General 7-7107
OHIO, Adena: P.O. Box 637, Kimball 6-2361
PENNSYLVANIA, Forty Fort: 43 Wells St., Butler 7-4762
Greensburg: 522 Hampton St., Temple 7-5555
Indiana: P.O. Box 208, Hopkins 3-0468
Johnstown: 221 Bertmin St., Tel. 32-1274
WEST VIRGINIA, Fairmont: P.O. Box 1181
Fayetteville: P.O. Box 21, Tel. 527
Logan: 644 Stratton St., PLaza 2-3245
South Charleston: 1242 Ridge Dr., Poplar 8-6490

WAREHOUSES

ALABAMA, Birmingham: American Transfer Warehouse Co., Inc., P.O. Box 2543, Fairfax 3-1501
ILLINOIS, West Frankfort: Frank Russell & Son, 401 S. Ida St., Tel. 77
INDIANA, Evansville 7: Evansville Warehouse Co., 28 S. E. 8th
KENTUCKY, Harlan: McComb Supply Co., Tel. 361
PENNSYLVANIA, Johnstown: Replogle Storage Co., 438 Horner St., Tel. 9-8713
Pittsburgh 19: Shovel Transfer & Storage Co., 210 W. Carson St., Express 1-4212
Wilkes-Barre: Matheson Warehouse Co., Elizabeth St., Forty Fort, Pa., BU 7-5495
TENNESSEE, Jellico: McComb Supply Co., Garfield 4-8441
VIRGINIA, Andover: Central Supply Co. of Va., Inc., Tel. 115
WEST VIRGINIA, Bluefield: City Warehouse Co., P.O. Box 1520
Fayetteville: Fayetteville Warehouse, c/o Mr. J. D. Bowling, P.O. Box 21, Tel. 527

Henlawson, Logan City: Hulburt Oil & Grease Co., Plaza 2-1153
Morgantown: Penna. & W. Va. Supply Corp., Tel. 4435
Wheeling: Penna. & W. Va. Supply Corp., P.O. Box 871, Linden 7-4710

I

IMPACT ROTOR TOOL, INC.
Route 30 East, Irwin, Pa., Underhill 3-7410

DISTRIBUTOR
WEST VIRGINIA, Huntington 18: J. H. Fletcher & Co., P.O. Box 2143, Jackson 5-7811

INGERSOLL RAND CO.
11 Broadway, New York 4, N.Y.

DISTRICT SALES OFFICES
ALABAMA, Birmingham 3: 1700 3d Ave., South, Fairfax 3-2576
COLORADO, Denver 2: 1641 Blake St., Keystone 4-2245
ILLINOIS, Chicago 6: 400 W. Madison St., Dearborn 2-4626
MISSOURI, St. Louis 3: 2327 Locust Blvd., Garfield 1-0888
NEW YORK, Buffalo 2: 117 W. Chippewa St., Cleveland 6437
New York 4: 11 Broadway, WHitehall 4-4750
OHIO, Cincinnati 6: 428 McGregor Ave., Plaza 1-8060
Cleveland 3: 4506 Chester Ave., Express 1-9889
PENNSYLVANIA, Philadelphia 3: 2037 Chestnut St., Locust 7-7535
Pittsburgh 22: 932 Penn Ave., Atlantic 1-9070
Scranton 5: 605 Davis St., Diamond 6-3885
TENNESSEE, Knoxville 24: 412 W. Jackson Ave., Phone 3-3145
UTAH, Salt Lake City 1: 144 S. W. Temple St., Davis 8-8127
VIRGINIA, Richmond 30: 3431 W. Leigh St., Phone ELgin 5-7871

INTERNATIONAL HARVESTER CO. CONSTRUCTION EQUIPMENT DIVISION
180 North Michigan Ave., Chicago 1, Illinois

DISTRICT SALES OFFICES
ILLINOIS, Peoria: 407 Rock Island Ave., P.O. Box 1019
Quincy: 630 North Second St.
Springfield: 126 West Jefferson St., P.O. Box 99
KENTUCKY, Louisville: 1326 West Walnut St.
MARYLAND: Baltimore: 6501 Quad Ave.
OHIO, Cincinnati 1: 2901 Gilbert Ave., P.O. Box 85
Columbus 4: 3700 Sullivant Ave., P.O. Box 2797
Toledo 1: 43 Fearing St.
PENNSYLVANIA, Harrisburg: 1017 Maclay St.
Leetsdale: 1000 Ferry St.
TENNESSEE, Memphis 2: 237 West Olive Ave., P.O. Box 2864
VIRGINIA, Richmond 23: 1702 East Clay St.

DISTRIBUTORS
ILLINOIS, East Peoria: McElroy-Roland Machinery Co., 2580 Morton Road
Quincy: Missouri-Illinois Tractor & Equipment Co., Inc. U.S. Highway No. 24, Box 328
Rockford: Howell Tractor & Equipment Co., Route 51 & Samuelson Road, P.O. Box 39
Springfield: McElroy-Roland Machinery Co., 816 N. 31st St., Hwy. 66 By-Pass
KENTUCKY, Louisville: Brandeis Machinery & Supply Co., 201 Warnock St., Box 1705
Middlesboro: Brandeis Machinery & Supply Co., North 19th St., Box 515
Paducah: Brandeis Machinery & Supply Co., U.S. Hwy. 45, Box 906
MARYLAND, Baltimore: Phillips Machinery & Tractor Co., 325 West 23rd St., Box "O" Hampden Station
OHIO, Cincinnati: Rish Equipment Co., 1212 Dalton Ave., Box 120
Cleveland: Rish Equipment Co., 9255 Brookpark Road, Box 7303
Columbus: Rish Equipment Co., 3131 Beulah Road, Box 6398
Dayton: Rish Equipment Co., 2375 Dryden Road, Box 543
Portsmouth: Rish Equipment Co., North on U.S. Route 23, Box 270
Toledo: Rish Equipment Co., 101 North Westwood, Box 206 Station C
Youngstown: Rish Equipment Co., 250 Indinola Ave., Box 2669
PENNSYLVANIA, Franklin: State Equipment Co., 655 Grant St.
Harrisburg: State Equipment Co., 3725 North Front St., Box 412
Kingston: State Equipment Co., 642 West Market St.
Philadelphia 43: Stewart Equipment Co. of Philadelphia, 52nd & Woodlawn Ave.
Philipsburg: State Equipment Co., Box 667
Pittsburgh: State Equipment Co., 8436 Perry Highway
TENNESSEE, Chattanooga, 5: Power Equipment Co., 1080 Duncan Ave., Box 3158
Kingsport: Power Equipment Co., 121 Clay St., Box 597
Knoxville 15: Power Equipment Co., 1430 Island Home Ave., S.E.
Nashville 3: Power Equipment Co. of Nashville, 808 Sixth Ave., North
VIRGINIA, Arlington: Phillips Machinery & Tractor Co., 2910 Jefferson Davis Highway
Norfolk 8: Hampton Roads Tractor & Equipment Co., Inc., West 39th St. & Killiam Ave., Box 237
Richmond 10: Rish Equipment Co. 1601 Chamberlayne Ave., Box 1260
Roanoke 7: Rish Equipment Co., 405 Center Ave., N.W. Box 1369
WEST VIRGINIA, Bluefield: Rish Equipment Co., Box 269
Bluefield: Rish Equipment Co., North on U. S. 52, Box 1261
Charleston 22: Rish Equipment Co., Kanawha Boulevard at Patrick St., Box 353
Clarksburg: Rish Equipment Co., East on U.S. Route 50, Box 2227
Parkersburg: Rish Equipment Co., 140 Nineteenth St., Box 1728

INTERSTATE EQUIPMENT CORP.
300 Mount Lebanon Blvd., Pittsburgh, Pa., Locust 3-5556

J

THE JEFFREY MFG. CO.
974 North Fourth St., Columbus 16, Ohio
ALABAMA, Birmingham 5: 3012 Fourth Ave., South, Fairfax 2-8516
COLORADO, Denver 2: 1726 Champa St., Suite 315, Tabor 5-3553
INDIANA, Evansville 7: 1066 Diamond Ave., Harrison 4-8206
KENTUCKY, Harlan: Martins Fork Road, P.O. Dr. 472 Phone: 400
PENNSYLVANIA, Pittsburgh 22: 1424 Oliver Bldg., Court 1-2926
UTAH, Salt Lake City: 445 E. 2nd South
WEST VIRGINIA, Bluefield: 1703 Jefferson St., P.O. Box 731, Davenport 5-7165

SERVICING AGENTS
INDIANA, Evansville: Evansville Electric & Mining Co.
KENTUCKY, Harlan: National Electric Service Corp.
PENNSYLVANIA, Portage: Leman Machine Co.
WEST VIRGINIA, Bluefield: National Electric Coil Co.

JOY MFG. CO.
Henry W. Oliver Bldg., Pittsburgh 22, Pa.

DISTRICT SALES OFFICES
COLORADO, Denver 2: 1626 Wazee St., Keystone 4-6334
DISTRICT OF COLUMBIA, Washington 6: 1741 K. St., N.W., Executive 3-6200
ILLINOIS, Chicago 6: 560 W. Washington Blvd., Dearborn 2-4670
MISSOURI, St. Louis 10: 1203 Macklind Ave., Mission 5-6670
MONTANA, Butte: 24 W. Granite St., Phone 6721
NEW YORK, New York 6: 100 Church St., Cortlandt 7-6545
OHIO, Cleveland 35: 16141 Puritan Ave., Clearwater 1-9444
OREGON, Portland 9: 1631 N.W. Thurman St., Capital 7-5561
PENNSYLVANIA, Luzerne: 453 Main St., Butler 8-4523
Philadelphia 2: 1420 Walnut St., Pennypacker 5-1414
Pittsburgh 16: 3021 Banksville Rd., Locust 3-4000
TENNESSEE, Knoxville 2: 108 W. Main St., Phone 24121
TEXAS, Dallas 20: 7425 Hines Blvd., Fleetwood 7-3948
UTAH, Salt Lake City 4: 998 S. Sixth West St., Davis 2-0481
WASHINGTON, Seattle 1: 2411 Western Ave., Mutual 2-2266
WEST VIRGINIA, Fairmont: P.O. Box 1045, Phone 1740
Huntington: 742 8th Ave., Jackson 3-3439

DISTRIBUTORS
ALABAMA, Birmingham: Crandall Engineering Co., 601 N. 10th St., Alpine 1-9262
COLORADO, Denver 2: Schloss & Shubart, 1626 Wazee St., Acoma 2-2741

JOY MFG. CO., ELECTRICAL PRODUCTS DIV.
1205 Macklind Ave., St. Louis, Mo.

K

KAISER ALUMINUM & CHEMICAL CORP.
Kaiser Center, 300 Lakeside Dr., Oakland 12, Calif.

DISTRICT SALES OFFICES
ALABAMA, Birmingham: 1206 20th St. South, Alpine 2-5196
ILLINOIS, Chicago 1: 360 North Michigan Ave., DEarborn 2-5080
KENTUCKY, Louisville 2: 823-3 Commonwealth Bldg., Fourth & Broadway, JUniper 4-2114
MISSOURI, St. Louis 5: 10 South Brentwood Blvd., Volunteer 3-1100
OHIO, Cincinnati 6: 2330 Victory Parkway, Capital 1-5550
Cleveland 13: 55 Public Square, SUperior 1-3000
Youngstown 12: 4005 Hillman St., STerling 8-2441
PENNSYLVANIA, Pittsburgh 22: 140 Stanwix St., EXpress 1-0280
York: 1771 East Market St., York 47-1028
TENNESSEE, Memphis: 3355 Popular Ave., FAirfax 3-8549

KENNAMETAL INC., MINING TOOL DIV.
Bedford, Pa., Phone 755

DISTRICT SALES OFFICES
ILLINOIS, Benton: 505 E. Lawrence St., Phone GE 8-8811
INDIANA, Vincennes: 224 Wilbur St., Phone TU 2-8944
KENTUCKY, Barbourville: 419 S. Main St., Box 337, Lincoln 6-3727
Belfry: Box 28, Phone William son, W. Va. AD 7-4468
OHIO, Crooksville: 303 Walnut St., Phone 4104
PENNSYLVANIA, Cadogan: Phone: Roger 29964
Glenshaw: 107 Orchard Ave., Hunter 6-5722
Latrobe: 215 Loyalhanna Ave., Keystone 74333
Mars: Box 236, National 5-9011
Rimersburg: Box No. 289, Phone 113
Waynesburg: Morning Side, RD No. 3 Phone 1734 (Orval Robson) Phone: 1076
Wyoming: 41 Shulde Lane, Phone: Wyoming 49
TENNESSEE, Chattanooga 11: 1314 S. Seminole Dr., Oxford 83021
UTAH, Springville: 164 W. 2 S., Hunter 9-5541
WEST VIRGINIA, Bluefield: Box No. 834, Davenport 7-8376
Morgantown: P.O. Box 1133, Phone Linden 2-9503
Oak Hill: 368 Kelly Ave., Hobart 9-9544

DISTRIBUTORS
ALABAMA, Birmingham: Salmon & Co., Inc.
KENTUCKY, Jenkins: National Mine Service Co.
Madisonville: National Mine Service Co.
NEW MEXICO, Carlsbad: Bit Grinding Service Inc.
PENNSYLVANIA, Forty-Fort: National Mine Service Co.
Indiana: National Mine Service Co.
Latrobe: McGinnis Bros. Bit Service Inc.
Washington: Fairmont Supply Co.
VIRGINIA, Andover: Central Supply Co. of Virginia Inc.
McClure: Erwin Supply Co.
WEST VIRGINIA, Beckley: National Mine Service Co.
Bluefield: Fairmont Supply Co.
Cowen: Pennsylvania & West Virginia Supply Corp.
Fairmont: Fairmont Supply Co.
Logan: National Mine Service Co.
Morgantown: National Mine Service Co., Pennsylvania & West Virginia Supply Corp.
Ravenswood: Fairmont Supply Co.
Shinnston: Erwin Supply Co.
Triadelphia: Pennsylvania & West Virginia Supply Corp.

KW-DART TRUCK CO.,
Kansas City, Mo.
1301 North Manchester Tfwy. HU 3-7679

FACTORY SALES OFFICES
NEW YORK, Long Beach: John C. Morley, 23 Virginia Ave.
OHIO, Cleveland: T. E. Sullenger, Westlake Hotel
OHIO, North Ridgeville: H. A. Noreen, 34554 Lorain Road

DISTRIBUTORS
ALABAMA, Birmingham: Leary & Owen Machinery Co., 3600 5th Ave.
Montgomery, Leary & Owens Equipment Co., 3165 Mobile Ave.
ILLINOIS, Oaklawn: Tractor & E Equipment Co., 10000 S. Ridgeland Ave.
INDIANA, Indianapolis: Flesch-Miller Tractor Co., 4611 Franklin Road
KENTUCKY, Lexington: Wilson Machinery Co., & Supply Co., 550 West 4th Street
MISSOURI, Kansas City: Funkhouser Machinery Co., 2425 Jefferson Street
OHIO, Cleveland: T. E. Sullenger 12525 Edgewater Dr., Apt. 222
Columbus: Cantwell Machinery Company, 830 North Cassidy Ave.
PENNSYLVANIA, Pittsburgh: Parkway Machinery, Inc., 635 Ridge Ave.
TENNESSEE, Nashville: McCarthy, Jones & Woodard, 723 Argyle Ave.
TEXAS, Dallas: Texas Kenworth Co., 7901 Harry Hines Blvd.
UTAH, Salt Lake City: J. T. Jenkins Co., 2281 S.W. Temple

VIRGINIA, Roanoke: Southern Machinery Co., 2757 Shenandoah Ave.
WEST VIRGINIA, Charleston: West Virginia Tractor & Equipment Co., P.O. Box 473

L

LEE-NORSE CO.

Charleroi, Pa., Hudson 3-6516

DISTRICT SALES OFFICES

COLORADO, Arvada: 6030 W. 55th Place, Harrison 4-2795
Boulder: 2975 18th Street, Hillcrest 3-6169
VIRGINIA, Pocahontas: Pocahontas Warehouse, Wilson 5-6945
WEST VIRGINIA, Bluefield: 112 Virginia Court, Davenport 5-7229

SALES AGENTS

ALABAMA, Birmingham: J. L. Thomas Company, 429 South 24th Street, Fairfax 4-7032
AUSTRALIA, Sydney, NSW. Noyes Bros. Pty. Ltd., 115 Clarence Street, Phone Bo254

LEHMAN MACHINE CO.

P.O. Box 236, Portage, Pa., Pershing 6-3731

LE ROI DIVISION, WESTINGHOUSE AIR BRAKE CO.

Milwaukee 1, Wisc.

DISTRIBUTORS

ALABAMA, Birmingham: Equipment Service Co., Inc., 617 N. 9th St.
Mobile: Equipment Service Co., Inc., 1000 S. Lawrence St.
COLORADO, Denver: Denver Air Machinery Co., 1421 Blake St.
INDIANA, Evansville: Austin Powder Co., 616 Northwest Second St., P.O. Box 177
KENTUCKY, Madisonville: Austin Powder Co., 39 Federal St., P.O. Box 146
UTAH, Salt Lake City: Atlas Equipment Co., 1595 South 2nd West, P.O. Box 26
WEST VIRGINIA, Clarksburg: West Virginia Mine Supply Co., P.O. Box 872
Huntington: Acme Machinery Co., Altizer Ave. & High St., (P.O. Box 2409)
Morgantown: Acme Machinery Co., Box 631

LIMA WORKS, CONSTRUCTION EQUIP. DIV., BALDWIN-LIMA-HAMILTON CORPORATION

Ohio, Lima—S. Main St., CA-40421

DISTRICT SALES OFFICES

GEORGIA, Atlanta 18: 1503 Northside Drive, N.W., Station D, TRinity 2-5833
INDIANA, Michigan City: 2503 Lake Shore Drive TRiangle 2-2598
MINNESOTA, Minneapolis 23: 2018 West 78th Street UNion 9-2338
OHIO, Lima: S. Main St. CA 4-0421
TEXAS, Dallas 7: 2356 Irving Blvd., RIverside 1-4719

DISTRIBUTORS

ALABAMA, Birmingham 6: G. C. Phillips Tractor Co., Inc., Woodlawn Station, 4419 First Ave., N., WOrth 1-4605
Mobile: 849 Telegraph Rd., HEmlock 3-5477
ILLINOIS. Chicago 32: Arrow Contractors Equipment Co., 4646 South Kedzie Avenue, FRontier 6-6500
Peoria: Machinery, Inc., 3601 Farmington Rd., 4-1174
Springfield: Springfield, Machinery, Inc., R.R. #1 8-7303
INDIANA, Evansville: Reid-Holcomb Company, Inc., Boonville Road East, GR 6-1348
Indianapolis 21: 1815 Kentucky Avenue, MElrose 2-4433
KENTUCKY, Louisville 13: Rudd Construction Equipment Co., Inc., 4344 Poplar Level Road, GLendale 2-2606
MISSOURI, St. Louis 10: Machinery Inc, 5081 Manchester Avenue, JEfferson 5-2056
OHIO, Cleveland 30: Cleveland Contractors Equipment Co., 10904 Brookpark Road, SHadyside 1-5570
Columbus 7: Columbus Equipment Company, 50 East Kingston Ave., Hickory 3-6541
OKLAHOMA, Oklahoma City: R. A. Young & Son, Inc., 1507 Exchange Avenue, CE 6-5465
PENNSYLVANIA, Harrisburg: Equipment & Supply Company, 5100 Paxton Street, JOrdan 4-3031
Hazleton: Frank Swabb Equipment Co., Inc., Suite 313, Hazleton National Bank Bldg., GLadstone 5-3658
Pittsburgh 6: Highway Equipment Company, 6465 Hamilton Avenue, EMerson 1-3600
SOUTH DAKOTA, Sioux Falls: Stan Houston Equipment Co., Inc., 2514 South Minnesota Avenue, 4-5605
TENNESSEE, Chattanooga: Story Brothers, Inc., 919 Dodds Avenue
Knoxville 18: 4130 Clinton Highway
Memphis 5: Priester Machinery Company, 249 S. Third Street, JAckson 5-6885
VIRGINIA, Roanoke: J. W. Burress, Inc., 1701 Shenandoah Ave., N.W., Diamond 3-1507
WEST VIRGINIA, Charleston: Machinery Inc., 2855 Piedmont Road, WAlnut 5-4741
Clarksburg: West Virginia Mine Supply Co., 212 Ohio Avenue, MAin 4-7491
CANADA, Regina, Saskatchewan: Blackwood Hodge Western Ltd., Lorne Street at 7th Avenue
Winnipeg 3, Manitoba: 1350 Wall Street, SPruce 5-7181

LINATEX CORP. OF AMERICA

P.O. DRAWER "D" Stafford Springs, Conn.; or Wilkins Linatex, Ltd., 1975 Bois Franc Rd., St. Laurent, Quebec, Canada

DISTRIBUTORS

MISSOURI, St. Louis 10: Shutt Process Equipment Corp., 5627 Manchester St.
NEW JERSEY, Bayway: U.S. James Jr., 712 Rockefeller St.
PENNSYLVANIA, Pittsburgh 19: S. E. Gane Co., 508 Grant St.

LINCOLN ENGINEERING CO., DIV. OF THE McNEILL MACHINE & ENGINEERING CO.

4010 Goodfellow Block, St. Louis 20, Mo.

FACTORY SALES OFFICES

ILLINOIS Chicago 22, Lincoln Engineering Co. (Chicago), 855 North Elston Ave., Chesapeake 3-0366
OHIO, Cleveland 28: Lincoln Lubricating Systems, Inc., 20801 Miles Parkway, Greenwood 5-2900
OREGON, Portland 14: Lincoln Engineering Co. of Calif., 1018 S. E. 8th Ave., Belmont 4-7469
PENNSYLVANIA, Philadelphia 40: Lincoln Engineering Co., 6th & Annsbury Sts., Davenport 9-1215
Pittsburgh 6: Lincoln Engineering Co., 134-36 S. Whitfield, Montrose 1-4444
TEXAS, Forth Worth 7: Keller-Hyden, Inc., P.O. Box 9008, Pershing 8-5451
CANADA, Scarborough, Ont.: Lincoln Engineering Co. (Canada) Ltd., 411 Birchmount Road, Oxford 8-2501

DISTRIBUTORS

MISSOURI, St. Louis: Jos. H. Yerkes & Co., 3624 Enright Ave., JE 1-6055
KENTUCKY, Ludlow: Riggs Engineering Co., Box 133, Hemlock 1-5362
PENNSYLVANIA, Pittsburgh: The Cypher Co., 1201 Washington Blvd., Montrose 1-4913

LINK-BELT COMPANY

Dept. CAMGL-60, Prudential Plaza, Chicago 1, Ill.

DISTRICT SALES OFFICES

ALABAMA, Birmingham 9: P.O. Box 6066, 1812-28th Ave., South, Tremont 1-1101
COLORADO, Denver: Schloss & Shubart, 1626 Wazee St., Acoma 2-2741
ILLINOIS, Chicago 9: 301 W. Pershing Rd., Atlantic 5-4401*
INDIANA, Indianapolis 6: 220 S. Belmont Ave., Melrose 2-5411
KENTUCKY, Louisville 8: 235 E. Burnett St., Melrose 7-3668
MICHIGAN, Detroit 4: 5938 Lindsdale Ave., Tyler 4-1100*
MISSOURI, Kansas City 8: 2630-Holmes St., Victor 2-9234*
St. Louis 1: 317 N. 11th St., Chestnut 1-1777
OHIO, Cleveland 20: 3592 Lee Rd., Wyoming 1-0380
PENNSYLVANIA, Pittsburgh 13: 5020 Center Ave., Museum 1-060*
WASHINGTON, Seattle 4: 3405 6th Ave. S., Seneca 8200*
WEST VIRGINIA, Huntington 1: 1009 5th Ave., P.O. Box 510, Jackson 3-9401
AUSTRALIA, Marrickville (Sidney): Rich St., P.O. Box 41*
BRAZIL, Sao Paulo: Rua Barao de Utapetininga 46
CANADA, Scarboro Toronto 13 Ont: 1960 Eglinton Ave., P.O. Box 173 Station H, Plymouth 5-4141*
SOUTH AFRICA, Springs: P.O. Box 287, Industry Rd., New Era Springs, Phone 56-6731*
*Includes Warehouse

LUDLOW-SAYLOR WIRE CLOTH CO.

634 S. Newstead Ave., St. Louis 10, Mo., Franklin 1-0636

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 1727 6th Ave. N., Alpine 2-5151
CALIFORNIA, Los Angeles 65: (Star Wire Screen & Iron Works, Inc., 2515 San Fernando Rd., Capitol 5-4101
COLORADO, Denver: 1530 Carr St., Belmont 3-5421
ILLINOIS, Chicago: 5807 W. Diversey Ave., National 2-1147
PENNSYLVANIA, Pittsburgh: Union Trust Bldg., Atlantic 1-2262
TEXAS, Houston: 5638 Harvey Wilson Drive, Walnut 1-0291

M

MACK TRUCKS, INC.

1355 W. Front St., Plainfield, N. J.

MACWHYTE CO.

2906 14th Ave., Kenosha, Wisc.

MAINTENANCE ENGINEERING CORP.

P.O. Box 10426, Pittsburgh 34, Pa.

MARION POWER SHOVEL CO.

Marion, Ohio

DISTRICT SALES OFFICES

ILLINOIS, Chicago: 332 S. Michigan Ave., Wabash 2-2701 & 2
INDIANA, Indianapolis: 5202 E. Dickson Rd., Liberty 7-4314
MISSOURI, Kansas City: 1016 Baltimore Ave., Rm. 309, Harrison 1-4228
St. Louis: 4378 Lindell Blvd., Jefferson 5-7727
NEW YORK, New York: 420 Lexington Ave., Murray Hill 9-6447
OHIO, Columbus: 2245 Nottingham Rd., Hudson 6-2054
PENNSYLVANIA, Emmaus: 105 Spruce St., Woodering 5-2990
Pittsburgh: 609 Kenilworth Dr., Lehigh 1-4446

DISTRIBUTORS

ALABAMA, Oneonta: Robbins Machine & Mfg. Co., Inc., Highway 75, North, Crestwood 4-3011
INDIANA, Indianapolis: Flesch-Miller Tractor Co., 4611 Franklin Road, Liberty 6-2491
KANSAS, Pittsburg: Henry W. Hubert Supply Co., 814 North Broadway, Phone Adams 1-2230
MISSOURI, Kansas City: Machinery & Supplies Co., Inc., 2000 Walnut St., Victor 2-5457
St. Louis: Ryan Equipment Co., 3350 Morgansford Rd., Prospect 1-0292
OHIO, Cincinnati: Bode-Finn Co., 2650 Spring Grove Ave., Mulberry 1-2200
Cleveland: J. J. Turner, Inc., 19451 Roseland Ave., Ivanhoe 1-9308
Toledo: Buckeye State Machinery, Inc., 3020 Reynolds Rd., Jefferson 1-1494
Dover: Weaver Truck Trailer & Body Corp., 2405-15 N. Wooster Ave., Phone 4-2391
PENNSYLVANIA, Carnegie: Allied Equipment Corp., 1 Glass St., Browning 9-5000
Philadelphia: Furnival Machinery Co., Lancaster Ave. at 54th St., Trinity 7-5200

MARLIN-ROCKWELL CORP.

Jamestown, N. Y.

DISTRICT SALES OFFICES

GEORGIA, Atlanta
ILLINOIS, Chicago
KANSAS, Wichita
NEW YORK, New York
OHIO, Cincinnati
Cleveland
PENNSYLVANIA, Philadelphia
OREGON, Portland: Brown Bearing
TEXAS, Dallas
WASHINGTON, Seattle: Brown Bearing
Spokane: Brown Bearing

McLANAHAN & STONE CORP.

Hollidaysburg, Pa., Phone 5-9807

DISTRIBUTORS

ALABAMA, Birmingham: Shook & Fletcher Supply Co., 1814 First Avenue, North, Fairfax 2-6722
ILLINOIS, Chicago: McLanahan & Stone Corp. (Chicago Office) 407 S. Dearborn St. WAbash 2-0733
INDIANA, Muncie: Van Doren Machinery Sales, 2503 Linden St., ATlas 4-4811
OHIO, Columbus: Cantwell Machinery Co., 830 N. Cassady Avenue, Clearbrook 8-9561
VIRGINIA, Roanoke: McIlhany Equipment Co., Inc., Corner 14th St. & Center Ave., N.W., Diamond 3-3669

WEST VIRGINIA, Bluefield: R. W. Massie, 1325 Lebanon St., Davenport 7-8461
Charleston: Persingers Inc., 520 Elizabeth Street, Dickens 6-5341
Williamson: Persinger Supply Co., Belmont 5-1400

McNALLY PITTSBURG MFG. CORP.

307 W. 3rd St., Pittsburg, Kansas, Adams 1-3000

DISTRICT SALES OFFICES

ILLINOIS, Chicago: 307 N. Michigan Ave., Franklin 2-5172
OHIO, Wellston: P.O. Box 228, Phone 4-2181
AUSTRALIA, Glebe, N. S. W.: A. E. Goodwin Ltd., 47 Forsyth St.
BRAZIL, Rio de Janeiro: Formac, S.A., Caixa Postal, 1310

MERRICK SCALE MFG. CO.

184 Autumn St., Passaic, N.J.

DISTRICT SALES OFFICES

ILLINOIS, Chicago: J. A. Marx, 400 West Madison St., Room 1904, FI 6-6786
KENTUCKY, Louisville: Charles Gipperich, P.O. Box 886, Glendale 4-4036
MISSOURI, Kansas City 12: W. C. Carolan Co., 612 West 47th St., Jefferson 1-5505
St. Louis: W. C. Carolan Co., 4030 Chouteau Ave., Jefferson 5-5525
PENNSYLVANIA, Pittsburgh: R. P. Hoppe Company, 300 Cedar Blvd. Fieldbrook 1-8400
TENNESSEE, Chattanooga 2: Edgar A. Rogers, Chattanooga Bank Bldg., Amherst 7-4640
VIRGINIA, Richmond 19: C. Arthur Weaver Co., Inc., 2612 West Cary St. Richmond, Elgin 9-5771
CANADA, Ontario, Toronto 9: Hagan Corp. (Canada) Ltd., P.O. Box 69, Station D, Roger 2-8285

METAL CARBIDES CO.

6001 Southern Blvd., Youngstown 12, Ohio

METALLURGICAL PRODUCTS DIV. GENERAL ELECTRIC

P.O. Box 237, Roosevelt Park Annex, Detroit 32, Mich.

MINE SAFETY APPLIANCES CO.

201 N. Braddock Ave., Pittsburgh 8, Pa., Churchill 1-5900

DISTRICT SALES OFFICES

ALABAMA, Birmingham: 2500 12th Ave., N., Alpine 4-3403
ARIZONA, Tucson: 1906 E. 18th St., Main 3-1814
COLORADO, Denver: 2916 Forest St., Florida 51588
ILLINOIS, Murphysboro: 2029 W. Walnut, Tel. 1613
KENTUCKY, Harlan: Third St., Rio Vista, Phone 130
Pikeville: 416½ Second St., General 7-6675
MINNESOTA, Duluth: 1703 East Third St., RAndolph 4-1997
MISSOURI, St. Louis 3: 1915 Washington Ave., Main 1-2252
MONTANA, Butte: 2419 Princeton Ave., Phone 6875
OHIO, St. Clairsville:
PENNSYLVANIA, Indiana: 241 Elm St., Phone: Hopkins 3-8850
Johnstown: 220 Leila St, Phone 35-1007
Pittsburgh 8: 7519 Penn Ave., Churchill 1-5900
Uniontown: 624 Fayette Nat. Bank Bldg., Geneve 8-7351
Scranton 10: 530 Clay Ave., Diamond 6-3062
UTAH, Salt Lake City 1: 257 Rio Grande St., Empire 4-6044
VIRGINIA, Norton: 840 Park Ave., Phone 888
WEST VIRGINIA, Bluefield: 1513 Bluefield Ave., Davenport 7-5171
Bridgeport: 523 Pennsylvania Ave., Victor 2-3230
Fairmont: 1313 Peacock Lane, Phone 909
Logan: P.O. Box 1306, Plaza 2-4959
Williamson: 38 Sunset Blvd., Belmont 5-5330
CANADA, Calgary, Alberta: 3632 Burnsland Rd., Chestnut 3-4092
Nova Scotia, Sydney: 150 Charlotte St., Phone 8370
Ontario, Toronto 4: 500 MacPherson Ave., Wanut 5-1101
Vancouver, B.C.: 293-11th Ave. East, Trinity 4-5711

MINE AND SMELTER SUPPLY CO.

3800 Race St., Denver, Colo., Cherry 4-4353

DISTRICT SALES OFFICES

NEW YORK, Mine and Smelter Supply Co., New York: 122 E. 42nd St., Murrayhill 2-0278
UTA 1, Salt Lake City: Mine and Smelter Supply Co., 121 West Second South, EM 3-2791

DISTRIBUTOR

WEST VIRGINIA, Fairmont: Fairmont Machinery Co., Fairmont 1672

MINERS' HARDWARE SUPPLY CO.

Martin Bldg., Pittsburgh 12, Pa., Fairfax 1-3013 & Allegheny 1-7257

N

NACHOD & UNITED STATES SIGNAL CO., INC.

4780 Crittenden Dr., Louisville 9, Ky., Emerson 3-3571

SALES OFFICES

UTAH, Salt Lake City: 375 South West Temple, DA 2-4311

NATIONAL MALLEABLE & STEEL CASTING CO.

10600 Quincy Ave., Cleveland 6, Ohio

NATIONAL MINE SERVICE CO.

Koppers Bldg., Pittsburgh 19, Pa.

DISTRICT SALES OFFICES

ALABAMA, Birmingham
ILLINOIS, Nashville
KENTUCKY, Ashland
Jenkins
Madisonville
PENNSYLVANIA, Mt. Carmel
Greensburg
Indiana
UTAH, Price
WEST VIRGINIA, Beckley
Logan
Morgantown
CANADA, Elliot Lake, Ontario: National Mine Service (Canada) Ltd.

NATIONAL TUBE DIV. OF UNITED STATES STEEL

525 William Penn Place, Pittsburgh 30, Pa.

DISTRICT SALES OFFICES

COLORADO, Denver: First National Bank Building, 621 17th Street
GEORGIA, Atlanta: Fulton National Bank Building, 55 Marietta Street, N.W.
ILLINOIS, Chicago: 208 South LaSalle Street
LOUISIANA, New Orleans: National Bank of Commerce Buiding, 210 Baronne Street
MASSACHUSETTS, Boston Statler Office Building, 20 Providence Street
MICHIGAN, Detroit: General Motors Building, 3044 W. Grand Boulevard
MINNESOTA, St. Paul: First National Bank Building, 334 Minnesota Street
MISSOURI, St. Louis: Shell Building, 1221 Locust Street
NEW YORK, New York: 71 Broadway
OKLAHOMA, Tulsa: Philtower Building, 423 S. Boston Street
PENNSYLVANIA, Philadelphia: 1617 Pennsylvania Boulevard
Pittsburgh: 525 William Penn Place
TEXAS, Dallas: 1505 Elm Street
Houston: Gulf Building, 712 Main Street

NOLAN CO., THE

Bowerston, Ohio, Phone 6-2771 & 6-2781

DISTRIBUTORS

ALABAMA, Birmingham: J. L. Thomas, 429 So. 24th St., Phone 54-7032
COLORADO, Denver 2: E. C. Horne Machinery Co., 1726 Champa St., Tabor 5-7015
ILLINOIS, Chicago: J. N. North Associates, P.O. Box 105, Harbert, Mich., New Buffalo, Mich., Lakeside 4106
PENNSYLVANIA, Pittsburgh: George C. Hutchinson, Jr., 800 Keenan Bldg., Atlantic 1-5860
UTAH, Castle Gate: Frank C. Memmott, P.O. Box 154, Phone Kennilworth, Utah, Granite 2-7094
WEST VIRGINIA, Huntington: Huntington Supply & Equipment Co., Huntington National Bank Bldg., Jackson 25562
CANADA, (Ontario) Toronto: Levitt-Safety Limited, 747 Vaughan Rd.

NORTH AMERICAN GEAR CO.

Blairsville, Pa.

O

OHIO BRASS CO.

360 North Main St., Mansfield, Ohio

DISTRICT SALES OFFICES

INDIANA, Evansville 13: 1414 S.E. First St., Harrison 2-2869
KENTUCKY, Neon: P.O. Box 187, Neon 2441
PENNSYLVANIA, Johnstown: 1513 Luzerne St., P.O. Box 301, Phone: 35-1274
Pittsburgh 22: 1017 Oliver Bldg., Mellon Sq., Atlantic 1-1727
WEST VIRGINIA, Bluefield: 424 Parkway, P.O. Box 1616, Davenport 5768-4
Fairmont: 1219 Bell Run Rd., Phone: 7379

SALES AGENT

ALABAMA, Birmingham 2: Shook & Fletcher Supply Co., Agent, 1814 First Ave., North, P.O. Box 2631, Fairfax 2-6722

P

PENNSYLVANIA CRUSHER DIV., BATH IRON WORKS CORP.

West Chester, Pa.

DISTRICT SALES OFFICES & AGENTS

ALABAMA, Birmingham 5: J. L. Thomas, 429 S. 24th Street, Fairfax 4-7032
ILLINOIS, Chicago 3: V. H. Jones Company, 100 W. Monroe Street, Financial 6-1667
MISSOURI, St. Louis 26: J. P. Hensel, 9515 Arban Drive, Victor 3-5921
PENNSYLVANIA, Pittsburgh 22: E. P. Dandridge, 412 Oliver Bldg., Atlantic 1-0485
UTAH, Salt Lake City: The Mine and Smelter Supply Company, 121 W. Second Street, Empire 3-2791

PHELPS DODGE COPPER PRODUCTS CO.

300 Park Ave., New York 22, N. Y.

PIERCE MANAGEMENT CORP.

Pennsylvania Power & Light Bldg., Scranton 3, Pa.

PLM PRODUCTS, INC.

3871 West 150th St., Cleveland 11, Ohio, Clearwater 2-6222

PORTER CO., INC., H.K., CONNORS STEEL DIV.

P.O. Box 158, Huntington, W. Va.

DISTRICT SALES OFFICES

ALABAMA, Birmingham: P. O. Box 2562

H. K. PORTER CO., INC., LESCHEN WIRE ROPE DIV.

2727 Hamilton Ave., St. Louis 12, Mo.

DISTRICT SALES OFFICES

CALIFORNIA, San Francisco 7: 520 4th St.
ILLINOIS, Chicago 7: 810 W. Washington Blvd.
NEW JERSEY, Newark 5: 219 Emmet St.

SALES AGENTS

INDIANA, Indianapolis: J. G. Tierney, 6110 E. Marilyn Road
PENNSYLVANIA, Emmaus: D. D. Somers, 523 N. 6th St.
VIRGINIA, Richmond: 413 N. Stafford Ave.

DISTRIBUTORS

KENTUCKY, Harlan: Beck Electrical Repair Co.
Lothair: Mine Service Co.
PENNSYLVANIA, Pittsburgh 26: Cobb Wire Rope & Supply, 501 McNeilly Rd.
Hazelton: Jayem Supply Co. Hazelton-McAdoo Hwy.
Clearfield: Clearfield Equipment Co.
WEST VIRGINIA, Bluefield: Bluefield Hardware Co.
Huntington: Logan Hdwe. & Sup. Co., P.O. Box 1895
Logan: Logan Hdwe. & Sup., P.O. Box 540
Charleston 23: Capital City Sup. Co., 544 Broad St.
Clarksburg: Osborn Machy. Co., Inc.
Kermit: Controller Block & Sup. Co.
Shinnston: Erwin Sup. & Hdwe. Co., Inc.
Elkins: Valley Supply Co., Inc.
TENNESSEE, Nashville: Buford Bros., Inc., 125—10th Ave. S.
Knoxville: Tidewater Sup. Co. 1506 Island Home Ave SE
OHIO, Cleveland 10: Air Compressors Rental Co., 19615 Nottingham Rd.
Zanesville: Goss Supply Co., 620 Marietta St.
Canton: Ralph Williams, Inc., 429 Waynesburg Rd.
INDIANA, Boonville: Vernon Hardware Co., West Side Square
Terre Haute: B. F. Crawford Co., 1921 So. Third St.
VIRGINIA, Norton: Norton Hardware Co., 415 Park Ave.

PORTER CO., INC., H.K., THERMOID DIV.

Tacony & Comly Sts., Philadelphia 24, Pa.

POST-GLOVER ELECTRIC CO.
Box 709, Covington, Ky.

PROPELLEX CHEMICAL CHROMALLOY CORP.
P.O. Box 187, Edwardsville, Ill.

R

REMA-TECH, INC.
2 Park Ave., New York 16, N.Y.

ROBERTS & SCHAEFER CO.
201 No. Wells St., Chicago 6, Ill.

JOHN A. ROEBLING'S SONS DIV. THE COLORADO FUEL & IRON CORP.
Box 321, Trenton 2, N. J.

DISTRICT SALES OFFICES

CALIFORNIA, Los Angeles 22: 5340 E. Harbor St., Raymond 3-6421
COLORADO, Denver 16: 4801 Jackson St., Fremont 7-2769
GEORGIA, Atlanta 10: 934 Avon Ave., S.W., Plaza 3-2151
ILLINOIS, Chicago 50: 5525 W. Roosevelt Rd., Bishop 2-1100
NEW YORK, New York 6: Whitehall 3-5200
OHIO, Cincinnati 15: 2340 Glendale-Milford Rd., Evendale, Princeton 1-6990
Cleveland 7: 13225 Lakewood Heights Blvd., Clearwater 2-6060
OKLAHOMA, Tulsa: 321 North Cheyenne St., Luther 2-5194
PENNSYLVANIA, Philadelphia 6: 230 Vine St., Market 7-2751
TEXAS, Houston 1: 6216 Navigation Blvd., Walnut 6-8316
Odessa: 1920 East 2nd St., Federal 7-1547
WASHINGTON, Seattle 4: 900 First Ave., South, Main 2-4992

ROME CABLE CORP.
Rome, New York

S

SALEM TOOL CO., THE
767 S. Ellsworth Ave., Salem, Ohio, Edgewood 7-3416

DISTRIBUTORS

ALABAMA, Birmingham 4: Cowin Co., 930 2nd Ave. N.
ARKANSAS, Fort Smith: R. A. Young & Son, Inc.
Little Rock: R. A. Young & Son, Inc., 301 S. 10th St.
COLORADO, Denver 16: Union Supply Co., 5460 Colorado Blvd.
IDAHO, Boise: Intermountain Equipment Co., Broadway at Myrtle Sts.
ILLINOIS, Mt. Vernon: Ed. Meyer Tractor Co.
INDIANA, Evansville: Austin Powder Co., Box 177
IOWA, Spreitzer, Inc., U.S. 30 West, Cedar Rapids
KANSAS, Pittsburg: W. A. Thomas Supply Co., 112-114 W. Pacific
KENTUCKY, Lexington 6: Wilson Machinery & Supply, 561 W. 4th St.
Louisville 18: Wilson Mach. & Supply Co. Box 165, Sub Sta
Owensboro: 2601 W. 4th St.
MONTANA, Helena: Hall-Perry Machine Co., 128 E. Lawrence St.
NEW YORK, New York 6: O. Philipp & Co., Inc. 19 Rector St.
OHIO, Cincinnati 14: Rish Equipment Co., P.O. Box 120 (Annex Sta.)
Cleveland 29: Rish Equipment Co. P.O. Box 7303
Columbus 11: Rish Equipment Co., P.O. Box 6398, Oakland Park Branch
Dayton 9: Rish Equipment Co., P.O. Box 543
Portsmouth: Rish Equipment Co., P.O. Box 270
Steubenville: Voto Mfg. & Sales Co., 525 N. Webster
Toledo 7: Rish Equipment Co., P.O. Box 206 (Sta. C)
Youngstown 7: Rish Equipment Co., 250 E. Indianola Ave.
OKLAHOMA, Tulsa: R. A. Young & Sons, Inc., 9401 E. Admiral Pl.
PENNSYLVANIA, Bethel Park: Whitmyre Equipt. Co., H., 336 Sunset Drive
SOUTH DAKOTA, Sioux Falls: J. D. Evans Equip. Co., 500 S. Cliff Ave.
TENNESSEE, Chattanooga: Nixon Machinery & Supply Co., 1300 Carter St.
Knoxville: Nixon Machinery & Supply Co., 3042 N. Central Ave.
Nashville: Nixon Machinery & Supply Co., 1211 Demonbreun St.
UTAH, Salt Lake City 15: Western Machinery Co., 2300 S. Main St.
VIRGINIA, Richmond: Rish Equipment Co., P.O. Box 1260
Roanoke: Rish Equipment Co., P.O. Box 1369
WASHINGTON, Seattle 4: Clyde Equipment Co., 3410 1st Ave. S.
Seattle: The Carrington Co., 91 Columbus St., (Alaskan Representative)
WEST VIRGINIA, Bluefield: Rish Equipment Co., P.O. Box 269
Charleston 22: Rish Equipment Co., P.O. Box 353
Clarksburg: Rish Equipment Co., P.O. Box 2227
Parkersburg: Rish Equipment Co., P.O. Box 1728
CANADA, Montreal, Que: Mussens Canada, Ltd., 65 Colborn St.

SANFORD-DAY IRON WORKS, INC.
Dale Ave., P.O. Box 1511, Knoxville 9, Tenn.

DISTRIBUTORS

ARIZONA, Phoenix: Equipment Sales, 720 South 19th St.
MICHIGAN, Iron Mountain: W. B. Thompson Co.
NEW MEXICO, Grants: Plateau Hardware, Inc., P.O. Box 896
CANADA, Toronto, Ont.: Howard Engineering, 159 Bay St.

SCHROEDER BROS.
Nichol Ave., McKees Rock, Pa

SECURITY ENGINEERING DIV., DRESSER INDUSTRIES, INC.
3400 W. Illinois, Dallas, Texas

SHELL OIL CO.
50 West 50th St., New York 20, N.Y.

DISTRICT SALES OFFICES

ILLINOIS, Chicago 5: 624 South Michigan Ave., Harrison 7-3080
INDIANA, Indianapolis 4: 450 North Meridian Street, Melrose 5-8321
LOUISIANA, New Orleans 12: P.O. Box 673 (Zone 7), Express 1331
MARYLAND, Baltimore 4: P.O. Box 6870, Valley 5-5600
MISSOURI, St. Louis 66: P.O. Drawer 522, Volunteer 3-0300
OHIO, Cleveland 1: P.O. Box 5818, Prospect 1-4466

THE W. R. STAMLER CORP.
P.O. Box 90, Paris, Kentucky

SALES AGENTS

ALABAMA, Birmingham 1: Salmon and Co., Inc., 609 North 9th St., F.A. 4-0625
NEW MEXICO, Carlsbad: Union Industrial Corp., P.O. Box 710, Tuxedo 5-2186
PENNSYLVANIA, McKees Rocks: Schroeder Bros. Corp., Nichol Ave., Box 72, Spaulding 1-4810
UTAH, Salt Lake City: Western Sales and Engineering Co., 375 South West Temple Ave., Davis 2-4311

SUN OIL CO.
1608 Walnut St., Philadelphia 3, Pennsylvania, KI 6-1600

DISTRICT SALES OFFICES

ILLINOIS, Oak Park (Chicago): 1515 N. Harlem Ave., Euclid 3-4100
INDIANA, Indianapolis: 715 E. 52nd St., Walnut 4-4513
KENTUCKY, Louisville 16: Bramer's Lane, Spring 6-4681
MISSOURI, St. Louis 3, 3419 Papin St., Prospect 1-9364
OHIO, Cincinnati 4: 2414 River Rd., Wabash 1-5500
Columbus 4: 3499 W. Broad St., Broadway 9-9421
Youngstown 12: 6331 Southern Blvd., Skyline 8-4581
PENNSYLVANIA, Allentown, Old Emmaus Pike, R. D. 2, Hemlock 4-9531
Brownsville: Route 88 W. Brownsville, State 5-7400
Exeter: 7 Kern St., Olympic 4-6795
Greensburg: Roosevelt Way & Route 119, Temple 7-4700
Johnstown: Tunnel Ave., Riverside Johnstown 33-2111
Pittsburgh 38: Freeport Road & Boyd Ave., Sterling 1-1252
WEST VIRGINIA, Huntington: 13th & Beach Sts., Kenova, Jackson 3-9045
Wheeling: Stop No. 22, River Road, Crestview 7-1122

T

TEMPLETON, KENLY & CO. BROADVIEW, ILL.

DISTRICT SALES OFFICE

PENNSYLVANIA, Pittsburgh: N. L. Montgomery, 245 Mabrick Ave. Fieldbrook 1-6357

DISTRIBUTORS

ALABAMA: Birmingham: Lewis Hardware Co., 420 N. 9 St.; Moore-Handley Hardware Co., 27 S. 20th St., Wimberly & Thomas Hardware Co., 1809 Ave. A.
COLORADO, Denver: Mine & Smelter Supply Co., Inc., 3800 Race St.
ILLINOIS, Du Quoin: Du Quoin Iron & Supply Co., Inc., Adams & Hickory
Marion; N. O. Nelson Co., 600 N. Van Buren St.
Mt. Vernon: Central Mine Supply Co., 218 So. 3rd St.
Murphysboro: Egyptian Sales Agency, 401 S. 17th St.
Peoria: Couch & Heyle, 1016 S. Adams
INDIANA: Evansville: Austin Powder Co., Inc., 616 N.W. 2d St., Drillmaster Supply Co., 1117 E. Division St.; Orr Iron Co., 1100 Pennsylvania St.
Terre Haute: Hardware Supply Co., Inc., 930-940 Chestnut St., Industrial Supply Co., 322-328 N. 9th St.
Mechanical Suppliers, Inc., 100 N. 9th St.
KANSAS: Pittsburg: General Machinery & Supply Co., 202 N. Bradway
KENTUCKY, Harlan: Kentucky Mine Supply Co., River St.
Hazard: Sterling Hardware Co., Inc., 124 Main St.
Madisonville: Austin Powder Co., 39 Federal St.
Paducah: Henry A. Peter Supply Co., 101-129 S. 1st St.
OHIO, Cambridge: Cambridge Machinery & Supply Co., 128 Steubenville Ave., Drawer 426
Cincinnati: Wm. T. Johnston Co., 1870 Summit Rd.; E. A. Kinsey Co., 331 W. 4th St.
Steubenville: Industrial Supplies Co., 324 N. 7th St.
Warren: Bert Park Co., 1199 Vine Ave., N.E., Warren Hdwe. Co., P.O. Box 1191
Zanesville: Buckeye Supply Co., 18 Harrison St.
OKLAHOMA, Oklahoma City: Marshall Supply & Equipment Co., 1241 West Main St., Mideke Supply Co., 100 E. Main St.
Tulsa 1: Leland Equipment Co., 408 Main St., Marshall Supply & Equipment Co., 920 E. Archer
PENNSYLVANIA, Bethel Park: Cooke-Wilson Electric Supply Co., 3000 Oakhurst Rd.
Forty Fort: National Mine Service
Greensburg: Westmoreland Hardware Co., 326 Mt. Pleasant St.
Indiana: Whitman Div. of National Mine Service Co., 1260 Maple St.
Johnstown: Quaker Sales Corp., P.O. Box 870; Thackray Co., 1036 Broad St.
Pittsburgh: C. A. Turner Inc., P.O. Box 928; Frick & Lindsay Co., Sandusky & Robinson Sts.; Harris Pump & Supply Co., Brady & Sidney Sts.; Pittsburgh Gage & Supply Co., P.O. Box 1168; Somer Fitler & Todd Co., 327 Fort Pitt Blvd.
Scranton: Bittenbender Co., 126-132, Franklin Ave.
Washington: Fairmont Supply Co., 437 Jefferson Ave.
W. Brownsville: Ward Supply Co., Inc.
Wilkes-Barre: Eastern Penn. Supply Co. Inc.
TENNESSEE, Johnson City: Summers Hardware & Supply Co.
Knoxville: C. M. McClung & Co., 501 W. Jackson Ave.; Tennessee Mill & Mine Supply Co., 406 State St. Tidewater Supply Co., P.O. Box 377
UTAH, Salt Lake City: Industrial Supply Co., Inc., Box 600; Mine & Smelter Supply Co., 121 W. 2nd South
VIRGINIA, Andover: Central Supply Co. of Virginia
Applachia: Central Supply Co. of Virginia
Grundy: Buchanan-Williamson Supply Co., Box 933
McClure: Erwin Supply & Hdwe. Co., Inc.
WASHINGTON, Seattle: Campbell Industrial Supply Co., 3433 Airport Way at Spokane St.; The Carrington Co., 91 Columbia St.
Tacoma: Hunt & Mottet Co., 2112 Pacific Ave.
WEST VIRGINIA, Beckley: Anchor Sales Co., 373 Prince St., Box 210, National Mine Service Co.
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Charleston: Capital City Supply Co., 522-524 Broad St., Box 883, McJunkin Corp., P.O. Box 513
Persingers Inc., 520 Elizabeth St., P.O. Box 1866, Rish Equipment Co., Box 353
Clarksburg: Rish Equipment Co., Box 2227
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Elkins: Valley Supply Co., 11th St. & Railroad Ave.
Elm Grove: Pa. & West Va. Supply Corp.
Fairmont: Fairmont Supply Co., 10th & Belt Line
Huntington: Banks-Miller Supply Co., 330 3d Ave.
Ensign Electric & Mfg. Co., 914 Adams Ave.
Kermit: Controller Block & Supply Co., Box P
Logan: Guyan Machinery Co., Inc. Logan Hardware & Supply Co., 300 Highland Ave.
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Chicago: Coalfield Company, 360 W. Jackson St.
Chicago: Vanguard Equipment & Supply Corp., 231 S. LaSalle St.
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Lyons: Producers Supply & Engineering Co., Inc., 4226 So. Lawndale Ave.
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Lothair: Mine Service Co.
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Pineville: Delaware Powder Co.
Winchester: Ace Bit Co., 2 Jefferson St.
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Steubenville: The Voto Manufacturers Sales Co., 523-525 North Webster Ave.
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Leechburg: Leechburg Supply Co., Lock Box 586
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Tremont: Tremont Hardware Co.
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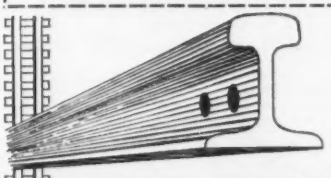
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2—6SC-7E Joy Shuttle Cars, matched pair
4—8SC Joy Shuttle Cars
6—5SC Joy Shuttle Cars, w/Elevators
10—42E Joy Shuttle Cars
12—32E-10 Joy Shuttle Cars
2—32E-16 Joy Shuttle Cars
7—32E & 32D Joy Shuttle Cars
2—20BU-1-3E Joy Loaders
3—20BU-1-4E Joy Loader, Permissible
4—14BU-7RAE Joy Loaders
4—14BU-PE Joy Loaders
1—14BU-7BE Joy Loader
7—14BU-2E Joy Loaders, 28" O.H.
3—12BU-9E Joy Loaders
3—11BU Loaders, 250 V., D.C.
5—8BU Joy Loaders, A.C. & D.C.
7—T2-5AE & T2-2E Joy Machine Trucks
2—T1-4G Joy Machine Trucks, 220 V., A.C.
7—PL11-7RPE, 7E, 8PE & 14RE Joy Elevators
1—WK-83R Joy Compressor, 240 cu. ft., rubber mounted, self-propelled
1—WL82 Sullivan Compressor, 125 cu. ft., rubber mounted, self-propelled
1—Lot 9J, 10J, 23J & 24J Motors

TIPPLE EQUIPMENT

1—Simon Carver, heavy duty, two compartment Baum Jig
1—Daniels Heavy Media Washer
1—4 Cell Jeffrey Baum Jig Washer, complete
1—48" CMI Dryer
1—48" McNally Pittsburgh Cent. Dryer
1—Heat Dryer, complete
1—36" x 130' Hot Material Handling Belt, Excellent
4—7' x 15' Single Deck Diester Tables
1—36" x 36" Jeffrey Single Roll Crusher
1—36" x 33" Marion Double Roll Primary Crusher
1—30" x 36" Jeffrey Double Roll Crusher, Like New
1—30" x 30" Link Belt Double Roll Crusher
1—24" x 50" Pa. Single Roll Crusher
2—24" x 24" Jeffrey Single Roll Crushers
1—2' x 4' Williams Pulverizer
1—18" x 12" Jeffrey Swing Hammer Pulverizer
1—6' x 16' Allis Chalmers Double Deck Low Head Vibrator
1—6' x 16' Allis Chalmers Double Deck Ripl-Flo Vibrator
1—6' x 16' Triple Deck Robbing Gyrex Vibrator, Like New
1—6' x 14' Single Deck Allis Chalmers Low Head Vibrator, Like New
1—5' x 16' Triple Deck Allis Chalmers Ripl-Flo Vibrator, Like New
1—5' x 16' Single Deck Allis Chalmers Low Head Vibrator, Like New
2—5' x 12' Allis Chalmers Single Deck Low Head Vibrators
1—5' x 12' Allis Chalmers Ripl-Flo Double Deck Vibrator
1—5' x 10' Double Deck Robbins-Gyro Vibrator, Like New
1—4' x 12' Hewitt Robbins Vibrex Screen, Triple Deck
1—4' x 10' Selectro Double Deck Vibrator
5—4' x 7' Jeffrey Traylor Double Deck Vibrators
2—4' x 7' Jeffrey Traylor Single Deck Vibrators
1—3' x 14' Single Deck Gyro Vibrator
2—3' x 8' Low Head Vibrators
1—30" x 72' Jeffrey Traylor Double Deck Vibrator
1—2' x 5' Loco Single Deck Vibrator
1—2' x 5' Selectro Double Deck Vibrator
9—24" x 90" Jeffrey Traylor Vibrators, w/M.G. Sets
2—Magnetic Separators, Complete
1—Set Jeffrey Dewatering Screens
14—Scraper Conveyors of various sizes
14—Drag Conveyors of various sizes
1—870' Jeffrey Rope & Button Conveyor
13—Boom Hoists from 1 ton to 5 ton
We can construct loading booms and tipple belts in any size.

BELT CONVEYORS

1,080'—36" Model "C" Joy Belt Conveyor
4—30" Goodman 97HC Belt Conveyors, 1,000' centers, tandem drive, 30 h.p.
9—30" Joy MTB Tandem Belt Conveyors, 1,000'
1—30" Shop Constructed Belt Conveyor Drive
288'—30" Barber Greene Belt Conveyor Structure
1—26" x 3,288' Joy MTB Belt Conveyor w/25 h.p. Tandem Drive
18—26" Belt Conveyor Drives of various types
8,808'—26" Joy Model "C" Belt Conveyor Structure

MISCELLANEOUS TRACKLESS EQUIPMENT

2—MT66-A45 Jeffrey Shuttle Cars, matched pair, permissible, excellent
1—70URB Jeffrey Cutting Machine
5—Long 88 & 88-C Pig Loaders
1—360 Goodman Loader on Rubber
2—Myers Whaley #63 Loaders
1—Lee Norse Jr. Continuous Miner
1—210 cu. ft. Acme Air Compressor
2—125 cu. ft. Acme Air Compressors
7—Manson Jeeps w/9J Motors
1—24BB Clarkson Loader

CUTTING MACHINES

1—70-URB Jeffrey Cutting Machine, 250 V. DC
5—11RU Joy Cutting Machines w/Bugdusters
3—29B Jeffrey Cutting Machines
1—29C Jeffrey Cutting Machine
1—824 Goodman Slabber
6—7AU Sullivans
5—7B Sullivans
16—11B Sullivans, 35 & 50 h.p., 250 V.
19—12AB, 12AA & 112AA Goodmans, 250 V.
9—212AA Baby Goodmans, 250 V.
16—512 Goodman Cutting Machines, w/Bugdusters, Hydraulic
2—512 Goodman Cutting Machines, 220 V. AC
1—712CJ Goodman Cutting Machine, 250 V. DC
1—29U Jeffrey, 220/440 V., A.C., Rebuilt
2—35L Jeffrey Cutting Machines
50—35B & 35BB Jeffrey Cutting Machines Bugdusters and Trucks available

SUB STATIONS & TRANSFORMERS

1—Westinghouse A.C. Sub Station, 4500 KVA, 6900/2300, complete w/boards, Excellent Condition
4—300KW M.G. Sets
5—200KW M.G. Sets
4—200KW, HCC-6-1200 G.E. Rotary Converters, Automatic
5—150KW G.E. Rotary Converters, w/Transformers
1—150KW Westinghouse Rotary Converter, Completely Automatic
20—150KW M.G. Sets of various makes and voltages
2—100KW M.G. Sets
1—100KVA Gasoline Alternator Unit
1—50KW M.G. Set 125 V. DC, 1200 rpm
2—Armatures for 200KW Rotary G.E., type HCC
2—600 & 800 Auto Transformers
222—Transformers from 1½KVA to 800KVA
1—45KVA, A.C. Alternator, 220/440 V., Like new

LOCOMOTIVES

1—20 Ton Jeffrey, MH77, 48" t.g., 6" armor plate frame, excellent condition
2—20 Ton MH77 Jeffreys, 42" t.g.
1—15 Ton HM828 G.E. Locomotive, 90 h.p. units, 44" O.H., 48" t.g., Excellent
1—14 Ton MH110 Jeffrey, 42" t.g.
8—13 Ton Locomotives, 250 V., any gauge
1—12 Ton 29B Goodman Locomotives, 40" O.H.
11—10 Ton Locomotives, 250 V., any gauge
21—8 Ton Locomotives, 250 V., any gauge
8—7 Ton Atlas Battery Locomotives
1—6 Ton Battery Locomotive, New
30—6 Ton Locomotives, any gauge
3—6 Ton Jeffrey MH150 Locomotives
16—6 Ton MH88 Jeffrey Locomotives
10—5 Ton Locomotives, 250 V.
18—4 Ton Locomotives, 250 V., any gauge
1—4 Ton G.E. Battery Locomotive
2—4 Ton Mancha Battery Locomotives
1—4 Ton 828 G.E. Battery Locomotive

CHAIN & SHAKER CONVEYORS

8—20" Joy Chain Conveyors, Permissible
5—15" Joy Chain Conveyors, Permissible
4—15" Long Chain Conveyors, 350' centers w/400DBH Long Mobile Head, A.C. & D.C.
10—15" 400-WT15 Long Chain Conveyors
1—15" Barber Greene Portable Chain Conveyor for unloading railroad cars
35—12" & 15" Jeffrey Chain Conveyors, 61AM and 61HG
1—12" Goodman 90L Chain Conveyor
2—PT12 Long Piggyback Conveyors
11—PT15-B Long Piggyback Conveyors
53—Goodman Power Duckbills and Duckbill Hoists, Model 477G
63—Goodman G12½, G15 and G20 Drives
7—Joy Ladel UN17 Shaker Drives

MINE CARS

90—36" t.g. Drop Bottom Cars
155—42" t.g. End Dump Cars, various makes
260—42" t.g. S. D. Drop Bottom Mine Cars
45—42" t.g. ACF Drop Bottom Cars
22—44" t.g. Drop Bottom Cars, 10 Ton
130—44" t.g. Drop Bottom Cars, various sizes
333—44" t.g. End Dump Cars, various sizes
327—48" t.g. S. D. Drop Bottom Cars
259—48" t.g. ACF Drop Bottom Cars
2—56½" t.g., 3 Ton, 4 Wheel Push Trucks (NEW)

RAIL AND WIRE

1,455—Tons 30, 40, 45, 56, 60, 65, 70, 80, 90 & 100 lb. Relaying Rail
325'—2,000,000 CM Bare Copper Feeder Cable
550'—1,000,000 CM Insulated Aluminum
650'—1,000,000 CM Bare Copper Feeder Cable
500'—350,000 CM Copper Feeder Cable, Insulated
2,000'—2/0 Stranded Copper, Bare
36,670'—2/0 Solid Copper Highline Wire
47,000'—1/0 Solid Copper Highline Wire
10,435'—#1 Solid Copper Highline Wire
10,945'—#2 Solid Copper Highline Wire
442'—#4 Solid Copper Highline Wire
3,700'—#6 Solid Copper Highline Wire
5,825'—4/0 Fig. 8 Trolley Wire
56,000'—6/0 Trolley Wire
1,600'—9 Section Trolley Wire
5,000'—2/0, 3 Cond. Anhydres & Lead covered transmission cable
10,000'—#2, 3 Cond. lead covered cable, 5,000 V.
6,000'—#1, 3 Cond. lead covered cable, 5,000 V.
2,500'—1¼" Steel Cable, New
600'—1¼" Steel Cable, New
Several thousand feet #2, #3 and #4 approved type machine cable.

MISCELLANEOUS

1—Canton Track Cleaner, Excellent
19—HKL HKG, HKD, HKC, HL & CH Brown Fayro & Sullivan Hoists
1—WK20 Sullivan Air Compressor, 120 cu. ft.
1—Cantrell Compresser, 120 cu. ft.
47—Air Compressors of various sizes
1,270—Edison Lamps, Model P and R4
57—Auto Starters from 3 h.p. to 100 h.p.
84—Hoists from 1½ h.p. to 800 h.p.
13—Shop Constructed Jeeps, track mounted
1—Prefab Building 14'8" x 16'
115—Pumps from ¾" to 4500 GPM
2—RBD30 C.P. Roof Drills
91—Coal Drills, various makes and sizes
1—330 GPM, 8" Pomona Deep Well Pump
1—14" Centrifugal Slurry Pump
14,357'—Pipe: galvanized, plastic & cast iron
45—Room Blowers, Brown Fayro & Jeffrey
31—Mine Fans from 30" to 9' Hi Pressure
17—Battery Chargers, various voltages
7—Series for Mine Tracks
12—Rock Dusters up to 30 h.p. track and rubber mounted
1—Dust Collector for Roof Bolting
1—Jet Creter Model CMC, Like New
5—Phillips Machine & Shuttle Car Carriers, 36" to 48" t.g.
1—42 Ton Richards Truck Scale, 10' x 25' Deck
769—Stationary Motors—½ to 800 h.p., AC & DC (List of motors available upon request)

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A.C. MINING EQUIPMENT FOR SALE

2—12G-3 Goodman Cutting Machines A.C.
1—112 Goodman Cutting Machine, A.C.
1—212 G-3 Goodman Cutting Machine, A.C.
1—8 BU Joy Loading Machine, 220 Volt A.C., 31" high equipped with stub boom for PT-12 Piggyback.
2—11BU-10APH Joy Loading Machines, 220/440 Volts A.C.
1—8BU-11G Joy Loading Machine, 220 Volts A.C. (can be changed to 440 Volts A.C.)
2—4JCM Joy Continuous Miners, 440 Volts A.C.
3—7B Sullivan Cutting Machines, 220/440 Volts A.C.
1—8BU Joy Loading Machine, 220/440 Volt A.C.
1—T-1 Joy Machine Truck, A.C.
1—T2-5 Joy Machine Truck, A.C.

LOADING MACHINES FOR SALE

1—18 HR Joy Loading Machine, 250 Volts D.C.
4—11 BU-10APE Joy Loading Machines, 250 Volts D.C.
2—14 BU-7BE Joy Loading Machines, 250 Volts D.C.
2—14 BU-3PE Joy Loading Machines, 250 Volts D.C.
6—12 BU-9E Joy Loading Machines, 250 Volts D.C.
1—8 BU Joy Loading Machine, 250 Volts D.C.
3—7 BU Joy Loading Machines, 250 Volts D.C.
2—Long 12" Piggyback Conveyors, each 300' long, complete with PT-12 Piggybacks and 12BU Joy Loading Machines.

SHUTTLE CARS FOR SALE

2—32E-16 Joy Shuttle Cars, 250 Volts D.C.
1—570-48 Goodman Shuttle Car, 250 Volts, D.C.
2—5SC Joy Shuttle Cars, Matched Pair, Elevating Discharge, Disc Brakes, 250 Volts D.C.—Modern.
1—6SC-7E Joy Shuttle Car.
2—6SC-5E Joy Shuttle Cars, Elevating Discharge, 4-Wheel Steering, 250 Volts D.C.
3—42E18 Joy Shuttle Cars, Disc Brakes, Elevating Discharge, Completely Modern, 250 Volts, D.C. 2-Standard, 1-Opposite Standard Drive.
1—32E16 Joy Shuttle Car, Disc Brakes & Elevating Discharge.
1—42E15A Joy Shuttle Car.
2—32 E-7 Joy Shuttle Cars.
1—10SC-2BPE Joy Shuttle Car, Permissible, equipped with 40J, 15 HP Motors, Matched pair.
1—10SC-2BPXE Joy Shuttle Car, Permissible, equipped with 40J, 15 HP Motors, Matched pair.

CUTTING MACHINES FOR SALE

2—29LC Jeffrey Cutting Machines, 250 Volts D.C.
1—512 CJ Goodman Cutting Machine, 50 H.P. with bunduster.
1—10RU Joy Cutting Machine, 250 Volt D.C. with bunduster.
2—29UC Jeffrey Universal Cutters, Permissible, 250 Volts D.C.
1—512 CCH Goodman Cutting Machine, 250 Volts D.C.
5—35B Jeffrey Cutting Machines, 250 Volts D.C.
6—35BB Jeffrey Cutting Machines, 250 Volts D.C.
1—512DA Goodman Cutting Machine, 250 Volts D.C.
2—7AU Sullivan Cutting Machines, 250 Volts D.C.
3—212 AB Goodman Machines.
2—412 AA Goodman Machines.
1—35L Jeffrey Machine.

CONTINUOUS MINERS FOR SALE

2—1CM Joy Continuous Miners, 250 Volts D.C.
3—4JCM Joy Continuous Miners, 440 Volts A.C.

RECTIFIERS FOR SALE

1—400 KW American Selenium Rectifier, 4160 Primary, 275 Volts D.C.

ROTARY CONVERTERS FOR SALE

1—300 KW Westinghouse, Pedestal Type Converter, 275 Volts D.C., Primary 2300/4000.
1—150 KW Rotary Converter, Serial No. 1054562, with 150 KVA transformer and panel boards.
1—100 KW General Electric HCC-6 Rotary Converter, 1200 RPM, 2300/4000 Volts Primary, 275 Volts D.C., Pedestal Type.
1—150 KW Westinghouse Rotary Converter, Pedestal Type, 1200 RPM, 2300/4000 Volts Primary, 275 Volts D.C.
1—200 KW General Electric HCC-6 Rotary Converter, 1200 RPM, 2300/4000 Volts Primary, 275 Volts D.C., Pedestal Type.

COAL DRILLS FOR SALE

1—Chicago Pneumatic RBD-30 Roof Drill.
25—CP-472 Electric Coal Drills, 250 Volts D.C.
5—CP-572 Coal Drills.
10—Chicago Pneumatic Little Giant 572 Coal Drills, 3 phase, 220 Volt A.C., permissible, New.
4—CD-25 Coal Drills, 250 Volts D.C.

CRUSHERS FOR SALE

1—Cedar Rapids 20" x 30" Swing Hammer Crusher.
1—36" x 36" Double Roll Crusher, complete with 100 H.P. Motor.
1—18" x 30" Double Roll, Double Drive, Scottdale Crusher.
1—Robins 36" x 36" Double Roll Stoker Crusher, specially built with spike teeth equipped with extra set of new segments.

COMPRESSORS FOR SALE

1—Joy WK-85 Air Compressor, Serial No. 53661, rubber mounted, self-propelled, 28½" high, Model 240, maximum pressure 100 lbs.
2—Acme Self-propelled Air Compressors, 83R, Model 168, Capacity 176CFM, with 40 H.P. Reliance Compound Motor. Excellent Condition.

LOCOMOTIVES FOR SALE

1—MH-88 Jeffrey Locomotive, 30" high with CY-21 Reel, 44" track gauge.
1—MH-150 Jeffrey Locomotive, 42" track gauge, 250 Volts D.C., 26½" high, rebuilt.
1—General Electric 6 Ton Locomotive with Reel, 36" gauge.
1—1030 Goodman Locomotive, 24" high, 44" track gauge.

ROCK DUSTERS FOR SALE

1—MSA Track Mounted Rock Duster, 10 H.P., A.C. or D.C., high pressure, 30" high, any gauge.
2—MSA Bantam Rock Dusters, Rubber Tired, Portable.
2—MSA Bantam Rock Dusters, Skid Mounted.
1—American Mine Door, Wheel mounted bantam type rock dusters, 250 volts D.C., 22" high.

HOISTS FOR SALE

2—Brownie Hoists, 5 H.P., A.C.
10—#11½ Vulcan-Denver Material Hoists, Complete with 3 H.P. D.C. Compound Wound 750 RPM General Electric Motor.
1—Brownie Hoist, Model HKM—Good condition.
3—Sullivan Type CHL, 5 H.P., Car Spotting Hoists.

ELEVATORS FOR SALE

2—Joy PL11-16 Elevating Conveyors.

MACHINE TRUCKS FOR SALE

1—T2-5APE Joy Machine Truck, 250 Volts D.C., equipped with hydraulic system for drill.
4—T2-5APE Joy Trucks, 250 Volts D.C. Permissible.

CHAIN CONVEYORS FOR SALE

5—61AM Jeffrey Chain Conveyors, 10 H.P. 300' long.
3—61HG Jeffrey Chain Conveyors, 5 H.P. 40° long.
1—Jeffrey 300 ft. 15" Chain Conveyor.

DIESEL PLANTS FOR SALE

1—60 KW G.M. Diesel Generator Set, with 60 KW, 250 Volt D.C. Delco Generator.
1—100 KW Waukesha Diesel Generator with 220/440 Volts D.C.
1—100 KW Diesel Generator Unit, with G.M. Diesel Engine and 100 KW Generator.
1—D13000 Caterpillar Diesel Generator Unit—with Caterpillar engine and 75 KVA G.E. generator self-regulating, 220 Volt A.C.

MOTOR GENERATORS FOR SALE

1—50 KW Westinghouse MG Set, 440 Volt A.C., 250 Volt D.C.
1—300KW Westinghouse Motor Generator Set, synchronous motor, 433 KW output, 435 KVA, 2200 Volts, 1200 RPM. D.C. generator 300 KW, 275 Volts, 1200 RPM. Compound Wound. Complete with D.C. panel and switch gear.
3—50 KW G.E. and Westinghouse Motor Generator Sets, 2300 Volts A.C., 275 Volts D.C. Complete with switching gear.
1—200 KW Ridgeway Motor Generator Set. Complete with switchgear and 1600 amp. I-T-E automatic circuit breaker, 2300 A.C., 275 Volts D.C.
1—150 KW General Electric Motor Generator Set, 2300 Primary, 275 Volts D.C.
1—150 KW General Electric Motor Generator Set, 440 Volts A.C. Primary, 275 Volts D.C.

BELT CONVEYORS FOR SALE

2—Joy 15"—300 ft. Chain Lines.
300 ft. Joy 15" Pans and Chains.
700 ft. Goodman 30", 97C Structure complete with drive.
2 only 1200' 26" Belt Conveyors with 30 H.P. 250 Volt D.C. Drives.

ROOF BOLTING MACHINES FOR SALE

5—Fletcher Roof Bolting Machines.

THE FOLLOWING OFFERED AS A PACKAGE UNIT ONLY

1—5CM Joy Continuous Miner, 440 Volts A.C.
2—16SC Joy Shuttle Cars, matched pair, 440 Volts AC.

MISCELLANEOUS FOR SALE

1—Compton Model 56 Auger with 300 H.P. Cummins Diesel Engine Drive, 210 feet 38" diameter auger (6 sections—35 feet each); 1—42" cutter head, 70 feet, 48" diameter auger (2 sections—35 feet each); 1—52" cutter head.
1—300 KVA Underground Transformer, Skid mounted, 40" high.
3—75 KVA Underground Transformers, skid mounted, 40" high.
3—30 KVA Underground Transformers, skid mounted, 40" high.
2—3 H.P. Gear Motors with 15" head and tail assemblies.
2—5 H.P. Gear Motors with 15" head and tail assemblies.
3—75 KVA Transformers, 2300/4000 Wye to 220 Volts.
3—35B Jeffrey Armatures, 250 Volts D.C.
4—902, 250 Volts D.C. Westinghouse Motor Units, only.
1—PL 11-14 Joy Elevator.
10—Goodman 512 Cutter Bars and Chains.
173—AC&F 42" Gauge, 48" high Drop Bottom Mine Cars. Condition like new.
1—24" Fan with drive.
2—7½ H.P. Tricycle Type Rubber Tired Mine Tractors, 7½ H.P. 220 Volt Single Phase Motors or 250 Volt D.C. Motors.
3—24 J Motors, 7½ H.P., 250 Volt D.C.
2—42" Track Gauge Phillips Carriers.
1—Manson Mine Jeep 40" Track Gauge equipped with 9J Motor.

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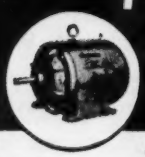
Locomotives—42" gauge GE 25 Ton diesel electric Class 50/50—Mancha 6 ton storage battery—W.E. 904C combination.
Locomotives—Standard gauge 65 Ton diesel electric Whitcomb Class 65 DE 19A. Will sell as 2 - 550V 1200 Amp. 251 HP Buda W.E. diesel electric generators.
Conveyors — Shakers Goodman, E-11 G 12½ G-15 units with jacks, ball-frames, troughs—Chains Jeffrey 61-W.
Apparatus—Mine rescue—MSA—all items for 2 rescue teams—McCaa-Gibbs-Chemox—all service masks—self rescuers—oxygen pumps etc.
Compressors—Sullivan Class WN-102.
Track Cleaners—Canton Models 30-40.
Fans—Meco 12" compressed air—Coppus TM8DC — Jeffrey Midget DC — Ingersoll Rand, Type FS, 3,150 C.F.M., 1lb./sq. in.
Hoists—Joy G-112 single drum—Ingersoll Rand A-5 NNOH double drum compressed air.
Stoker — Coxe traveling grate Type B 3,000 lbs. #4 Buck anthracite per hour with Canton flow tube conveyor and automatic controls.
Loaders—Farquhar Belt Ace Model 334 DC—Rock Mucker Conway 115 DC—Pit car Long 603 E compressed air.
Generators—G.E. Co. Type MPC, 250V DC 200 KW—750 R.P.M. with controls—no motor—Buda W.E. diesel electric 1,200 R.P.M.—550V DC—600 KW.
Drills—Long hole—Jeffrey A6A with drill rods and bits.
Motors — All 250V DC—15 HP 1,150 R.P.M. Goodman frame 155—50 HP 1,150 R.P.M. W.E. frame 133—15 HP —3,500 R.P.M. Louis Allis frame 774—20 HP 1,150 R.P.M. W.E. SK 90— 15 HP 1,150 R.P.M. Allis Chalmers frame 284—3 HP 1,750 R.P.M. Kimble Electric Class BA.
Miscellaneous—Timber lift Rugger Model TL-1—timber peeler Crouse HP 228—Arches steel yielding Bethlehem Steel 12'W x 10'H — chutes spiral lowering Robert Holmes 6' diameter x 60 feet—Elec. welder wire feed unit.
Mine Supplies — Electric cables—wire rope—pipe fittings—ball bearings—bolts —welding rods—long-leaf yellow pine shaft timber—sheets—plates—shafting structural steel and many others.

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HP	MAKE	TYPE	SPEED
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100	West. S.B Open	SK-170	90
100	C.W.T.E.F.C.B.B.	53 HFC	900
75	West. S.B. Open	SK-140L	1800
75	West. S.B. Open	SK-160	900
60	G.E.B.B. Drip	CDM-95	1800
60	Al. Chal. S.B. Drip	DE-131	1200
45	G.E.S.B. Open, Shunt	RC-14	1200
40	Century B.B. Drip-new	DN375	1800
30	West. B.B. Drip New	SK-93	1800
25	West. S.B. Open	SK-100L	1200
25	G.E.B.B. Shunt	CD-93	1200
10	G.E.B.B. Splash	CD-85	1800
10	West. B.B. Drip.	CSP-324	1800
7½	G.E.T.E.F.C. B.B. New	B-284	1800
5	L.A.B.B. Drip	OSNA-254	1800

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2—Jeffrey 29UC Cutting Machines, Universal head, cuts anywhere in seam, 38″ high, on Crawlers, 250 volt D.C.
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2—Goodman 724 Slabbers.
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2—61WH 15″ Room Conveyors, 300′.
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2—GMC-671 Diesels with 75KW, 250 V. DC Gen.
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Boilers, like new, 500 H.P.

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2—Goodman 660 Loaders, 440 V. A.C., perfect.
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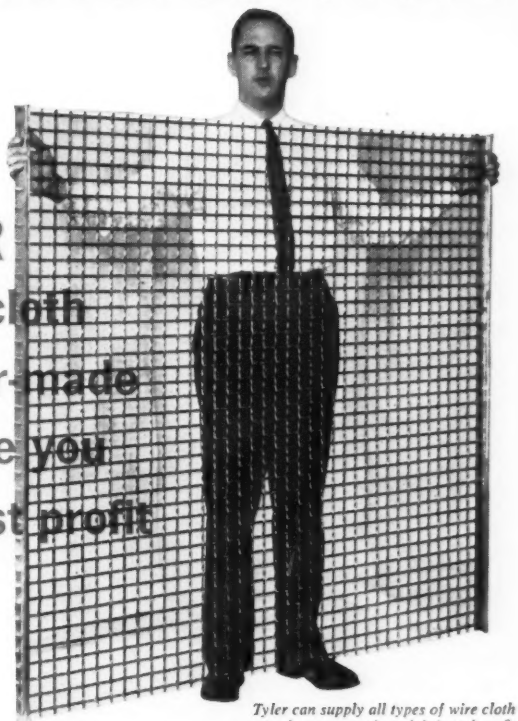
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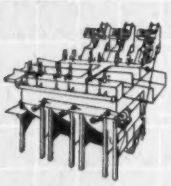
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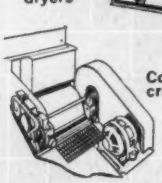

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